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THIRTY-EIGHTH

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER COMPANY

ON

BATTALION ANTI-TANK PROJECT

UNDER

Contract Nos. DA-33-019-ORD-33
DA-33-019-ORD-1202

ORDNANCE DEPARTMENT PROJECTS
TS4-4020—WEAPONS AND ACCESSORIES
TM1-1540—AMMUNITION

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THE FIRESTONE TIRE & RUBBER COMPANY
Defense Research Division
Akron, Ohio

SEPTEMBER 1953

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SECURITY INFORMATION

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THIRTY-EIGHTH

PROGRESS REPORT

OF

THE FIRESTONE TIRE & RUBBER CO.

ON

BATTALION ANTI-TANK PROJECT

Contract Nos.
DA-33-019-ORD-33 (Negotiated)
DA-33-019-ORD-1202

RAD Nos. ORDTS 1-12383
ORDTS 3-3955
ORDTS 3-3957
ORDTA 3-3952

THE FIRESTONE TIRE & RUBBER CO.
Defense Research Division
Akron, Ohio

SEPTEMBER, 1953

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INDEX

ABSTRACT

ONTOS System - The ONTOS mount and remote control firing system, developed by Firestone, was delivered to Aberdeen Proving Ground in August and was tested in September. The test results are given. The development and testing of the blast switches, as designed for the ONTOS system, are reviewed. The future plans for the ONTOS system as decided at a conference at OCO on September 23 are reported.

BAT Weapon System - The 90mm high velocity BAT rifle is substantially complete and proof testing will begin in October.

Primer Evaluation - Tests to evaluate the hole pattern on T88 primers are discussed.

T119 Projectile - Tests were conducted to investigate the accuracy of the T119E11 projectile and the uniformity of spin rate (muzzle and terminal) when the projectiles were equipped with rubber obturating rings. The test data are presented and discussed.

A series of tests were conducted to determine the optimum weight of rayon to be used in rayon fabric-polyethylene laminated liners. The effects of two types of liners on the interior ballistics are compared.

T171 Projectile - An accuracy firing of T171 MD10 projectiles was conducted at Erie Ordnance Depot and the test results are presented.

Penetration Studies - Studies concerned with the comparative penetrations of shaped charges into mild steel and homogeneous armor plate have continued. Some background data from previous tests are summarized and the data from 15 additional rounds fired at Erie Ordnance Depot are presented.

A test was conducted to compare penetration results of DRB398-9 copper cones when assembled in (1) T119E11 projectiles (2) T119E11 projectiles with shortened bodies (3) regular penetration test bodies with T119E11 ogives and (4) regular test assemblies. The data are given.

Tests were conducted with aluminum cones to study the effect of standoff and cone wall thickness and to compare the performance of cones of two different aluminum alloys. The data are presented, and summarized.

Fuzes - Functioning tests with T267E14 base elements were conducted. The test data are given.

Studies involving nose cap revisions to increase graze sensitivity are reported.

An investigation of the effectiveness of resistance washers in preventing prematures is described.

THE WEAPON SYSTEM

ONTOS Mount and Firing System

The ONTOS mount and remote control system, developed by Firestone and illustrated and described in the Thirty-Sixth Progress Report, was completed in August and shipped to Aberdeen Proving Ground where tests were conducted from August 25 to September 3, and from September 19 to September 24, 1953.

Functioning Tests at Aberdeen Proving Ground

August 25 to September 3, 1953

The system was mounted on an ONTOS vehicle and after a functional check by Firestone personnel was tested by Aberdeen Proving Ground personnel.

Boresighting

In the process of boresighting the rifles, it was found that the rifles would shift off boresight approximately ± 1/2 mil if the muzzle of a rifle was moved by hand. By avoiding this movement the rifles were boresighted and test firings conducted, but following the tests the rifle brackets were returned to Akron for re-machining. There was some metal interference under the quick-disconnect pad which prevented the rifles from clamping securely in the brackets.

Blast Switches

The first tests with this ONTOS system were fired from the number 4, 5 and 6 rifle positions, using T184 projectiles. Although the blast switches on the rifles fired,functioned properly, it was noted that the indicator lights for adjacent unfired rifles were indicating they had been fired. This malfunction was traced to the tripping of the relays in the control panel by the shock resulting from the firing.

The panel was disassembled and the relays adjusted so as to require greater travel in order to release. When firing was resumed none of the indicator lights functioned. Modified lever arms were utilized in the blast switches but they still did not operate properly. The blast switches were then returned to Akron for examination and further tests.

Functioning Tests of Blast Switches at

Erie Ordnance Depot

The difficulty encountered with the blast switch in the tests at Aberdeen Proving Ground prompted (1) a review of the development and testing of blast switches previous to the tests at Aberdeen on August 25 - September 13, and (2) a program to establish the cause of malfunctions during the tests at Aberdeen and to modify blast switch design according to the test data.

The blast switch, as designed for the ONTOS system, utilizes the back blast from a fired round to close a circuit which energizes a 24-volt relay. The relay contacts are in series with red and green indicator lights - the red indicator to light when the breech is closed and the green indicator to light when the gun is fired.

Several types of diaphragm contact switches and a cylinder actuating contact switch were tested and discarded due to erratic functioning. An arm contact type switch was developed and is illustrated in Fig. 1. The back blast from the rear

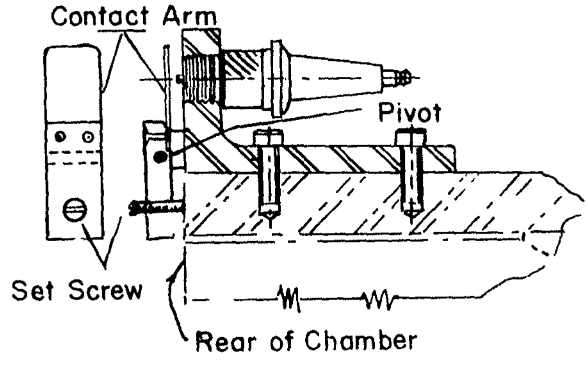


Fig. 1. Arm Contact Type Blast Switch.
Set Screw Adjustment.

of the chamber exerts a force on the under side of the arm which rotates on a pin and the spring steel contact, mounted on the end of the arm away from the chamber is thrown against the contact point of the spark plug, completing the circuit to the 24-volt relay (Fig. 2). The original arm

When the blast switches were returned to Erie Ordnance Depot, two series of tests were conducted (1) exploratory tests with several types of switches and (2) tests with the switches returned from the Aberdeen tests. Table I gives the results of 25 rounds fired with various

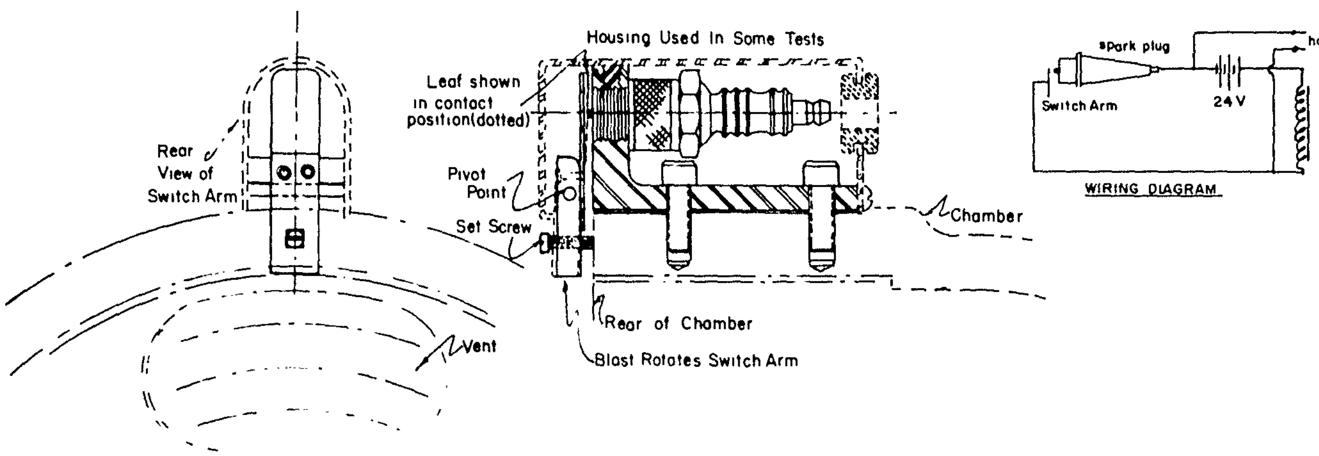


Fig. 2. Installation of Blast Switch.
Showing Circuit Diagram

had a set screw to adjust the gap between the arm and the chamber. In four different series of tests a total of 64 rounds were fired with this type of switch without malfunction.

In preparing the lever arms for the test unit at Aberdeen the set screw was replaced by a flange which gave a predetermined tension on the leaf or contact spring (Fig. 3). These switches were the ones which failed to function in the tests at Aberdeen.

switch types and Table II records the results with the returned switches. Fig. 4 shows the polaroid pictures of two rounds in these tests which show positive contacts of good length. Round 5866 was of the flange type and 5869 was a balanced arm type (both illustrated in Table II) with a multi-leaf beryllium contact spring to give greater pre-load on the lever arm. Switches of this kind were prepared and returned to Aberdeen for additional tests.

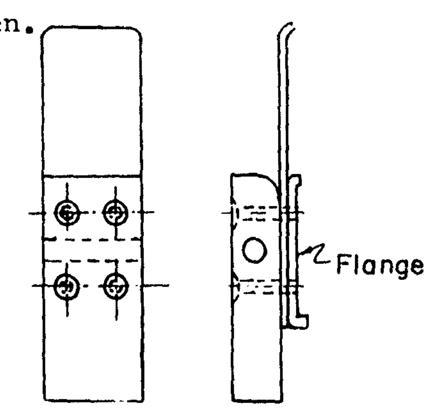


Fig. 3. Flange Type Contact Arm.
For Blast Switch.

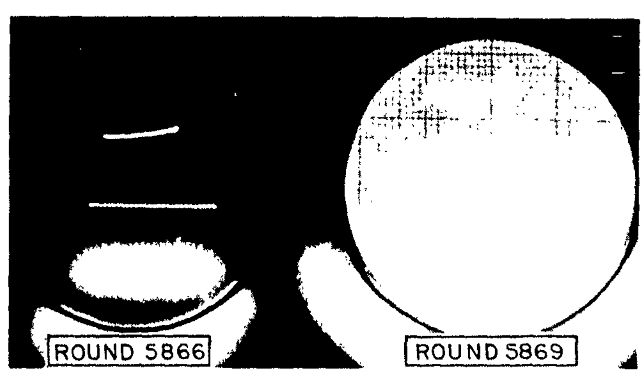
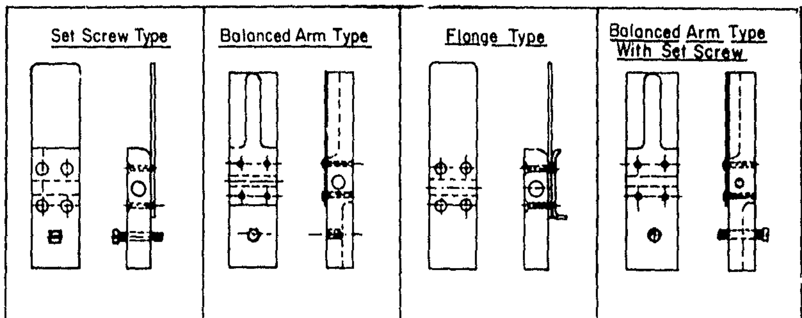


Fig. 4. Polaroid Records of Two Contacts.
Oscilloscope Traces For Rounds 5866 and 5869.

Table I
Functioning Tests
Various Types of Blast Switches



Test No.	Date	Round No.	Type Switch	Function	Remarks
11	9-14-53	5854-1	set screw	Yes	This type functioned
"	"	5855-2	bal. arm	No	64 consecutive times
"	"	5856-3	flange	No	
"	"	5857-4	set screw	Yes	
"	"	5858-5	bal. arm	No	
"	"	5859-6	flange	No	
12	9-15-53	5860-1	mod. bal. arm*	No	Beryllium copper contact
"	"	5861-2	" " "	No	
"	"	5862-3	" " "	Yes	**
"	"	5863-4	" " "	No	Steel contact
"	"	5864-5	flange	Yes	***
"	"	5865-6	"	Yes	
"	"	5866-7	"	Yes	
"	"	5867-8	"	Yes	
13	9-16-53	5869-1	bal. arm	Yes	Beryllium copper contact
"	"	5870-2	" "	Yes	" " "
"	"	5871-3	" "	Yes	*4
"	"	5872-4	mod. flange	Yes	*5
"	"	5873-5	" "	No	3 threads gap
"	"	5874-6	" "	No	" " "
"	"	5875-7	" "	No	" " "
"	"	5876-8	bal. arm	Yes	Beryllium copper contact
"	"	5877-9	mod. flange	Yes	*6
"	"	5878-10	" "	Yes	*6

All rounds fired from F-23 Chamber; using T149E3 mount.
* balanced arm modified by adding set screw.
** contact arm bent forward and corners of arm filed.
*** spring steel contact, .020 gap between arm and chamber.
*4 cover put over switch assembly.
*5 flange type modified by adding set screw.
*6 two guns fired simultaneously.

Table II
Functioning Tests
Blast Switches Returned From Aberdeen Proving Ground

Round No.	Switch	Adjustments made Prior to Firing	Function	Remarks
1	Switch No. 3	Set screw had 5 threads exposed. Ground wire put on housing screw.	Function	Switches returned from Aberdeen and which had flange removed and set screw inserted were given Nos. 1, 2 and 3.
2	Balanced Arm, Spring Double Thickness	Spring had to be bent to prevent continual contact. Only 3 threads could be exposed on set screw.	Function	
3	"	Blast Switch housing was installed.	Function	
4	Switch No. 3	Blast switch housing used. 3 Threads exposed.	Function	
5	Switch No. 1	"	Function	
6	Switch No. 2	"	No Function	
7	Switch No. 3	Sister gun fired	No Function	Sister gun refers to a gun placed parallel to and 20 in. from gun upon which blast switch is mounted.
8	Balanced Arm	Blast Switch housing used. 3 threads exposed. Sister gun fired	No Function	
9	Switch No. 3	2 parallel guns with 20 in. between firing pin caps fired simultaneously. Blast switch on only one gun.	Function	
10	Switch No. 3	"	Function	
11	Switch No. 2	Same as round No. 6	Function	Lever pin fits very tight.

Functioning Tests at Aberdeen Proving Ground

September 19 to 24

Boresighting

Retention of boresight in the remachined rifle brackets was still not satisfactory. The rifles moved off boresight by approximately ± 1/4 mil. Observers reported that some rifles were still not seating properly in the mounting brackets.

Blast Switches

With the revised switches, of a type that had functioned in tests at Erie Ordnance Depot and with the control panel mounted on rubber shock pads, test firing was resumed on September 23.

Firing No. 6 rifle (switch had been tested at E.O.D.) the system functioned perfectly. Firing No. 5 rifle (switch of same type but not tested at E.O.D.) the blast switch failed to indicate 3 out of 4 rounds fired and using rifle No. 4 the blast switch (of the type that functioned on No. 6 rifle but not actually tested at E.O.D.) failed completely. The blast switch lever arms were replaced with lever arms of the design with adjusting screws and these also failed to function. Firing was discontinued to prepare the units for a demonstration.

It was the opinion of an observer that the multiple leaf contact was not producing a positive contact due to the two leaves acting separately.

Salvo Tests

Rifle combinations, Nos. 4 and 6 and Nos. 5 and 6 were fired as 2-round salvos. Hits were obtained on the target but there was considerable dispersion.

ONTOS Conference

An ONTOS meeting was held at OCO on September 23 to discuss future plans for the ONTOS system. Considering the recommendations of Board No. 3 at Fort Benning and the Marines at Quantico it was decided that future systems would be as follows:

a. Indicator System -	The Harvey Machine Co. Pick-Up Device
b. Breech Control -	Allis Chalmers Hydraulic Mechanical System
c. Firing System -	Allis Chalmers Mechanical System
d. Rifle Mounting -	The Harvey Machine Co. System of Mounting Brackets

Firestone was requested to continue the development and testing of the blast type indicator for future use.

BAT Weapon System

The 90mm high velocity BAT rifle is substantially complete. It is anticipated the proof testing will be started during October.

Primer Evaluation

A preliminary evaluation of the T88 type primer was reported in the Twenty-Seventh Progress Report. At that time it was reported that the T88 primer gave a somewhat smaller temperature coefficient and a more uniform recoil than the M57 primer with which it was compared. The T88 primer was designed to produce symmetrical ignition of the propellent by using vent holes which were graduated in size. The first eight vent holes at the head end are .06 in. diameter, the next eight .12 in. diameter, and the final twenty-four holes .18 in. diameter. This hole pattern was chosen so that the liner paper would not rupture at the head end until burning of the black powder is essentially complete and then the liner paper will be ruptured at all holes simultaneously.

The small diameter holes have caused some difficulty in manufacturing T88 primers. To further test this primer type and also to determine if the smallest holes were necessary for good ignition several modifications of the basic T88 were prepared. Table III shows these modifications.

The various primer types were evaluated by firing at 70°, 0°, -20° -40°F. The propellent used was M10, MP, PA 30252, charge 7 lb. 1 oz., and the projectiles were test slugs. The results of these tests are given in Table IV. There is no significant difference between the performance of any of the types tested.

It is important to note, however, that satisfactory ignition was obtained with all of the types tested and that black powder charges of 300 to 600 grains were used in these closed end primers while 1000 grains are used in the M57 primer which is an open end primer.

The smaller black powder content of the closed end primer is desirable at elevated temperatures and this type of primer should be considered for use in any new shell development. Since the M57 primer is giving satisfactory performance with the T119 round no primer change for this round is indicated.

Future Program

BAT Project

a. Continue design work on a lightweight mount for the 90mm rifle.

b. Start proof testing and evaluation of 90mm BAT rifle.

ONTOS

a. Return Firestone ONTOS system to Erie Ordnance Depot for continued development of blast-type indicator system.

Table III
Primer Modifications

Type	Charge	Hole Pattern
T88E1	300 gr.	T88E1 standard
T88 (mod 1)	400	" "
T88 (mod 2)	300	.06 in. holes replaced with .12 in.
T88 (mod 3)	400	" " " " "
T88 (mod 4)	300	.06 in. holes omitted
T88 (mod 5)	400	" " "
M57	1000	M57
M57 (mod 1)	300	M57 body, T88E1 hole pattern
M57 (mod 2)	600	" " " " "
M57 (mod 3)	300	.06 in. holes omitted
M57 (mod 4)	600	" " "

Table IV
Primer Evaluation

Primer	Temperature (°F)	Velocity fps	Piezo Pressure (psi)	Copper Pressure (psi)	Recoil (in.)
M57	-42	1467	10,356	7,400	5.4
	-23	1478	10,523	8,100	2.4
	-4	1507	11,407	9,000	4.1
	77	1577	12,815	11,000	4.1
M57 MOD. 1	-42	1462	9,961	6,600	1.0
	-23	1487	10,631	8,100	1.8
	-4	1485	10,493	8,100	0.3
M57 MOD. 2	-42	1479	10,376	7,500	3.0
	-23	1483	10,047	8,000	0.7
	-4	1508	11,153	8,700	1.2
M57 MOD. 3	-42	1471	9,688	7,400	1.3
	-23	1478	10,275	8,000	0.3
	-4	1501	10,933	8,600	1.0
M57 MOD. 4	-42	1485	10,494	7,000	1.8
	-23	1493	10,652	8,400	1.8
	-4	1492	10,904	8,600	2.2
T88	-42	1454	10,227	7,300	3.5
	-23	1485	10,486	7,900	1.1
	-4	1503	11,324	8,800	1.7
	77	1569	12,689	10,000	3.0
T88 MOD. 1	-42	1437	9,821	6,600	3.4
	-23	1471	10,077	8,100	3.8
	-4	1483	11,250	8,400	5.0
	77	1571	13,094	9,700	4.0
T88 MOD. 2	-42	1471	9,853	7,100	2.6
	-23	1490	9,579	8,000	3.5
	-4	1501	11,150	8,400	2.8
	77	1571	12,917	10,400	2.9
T88 MOD. 3	-42	1450	9,606	6,600	3.0
	-23	1478	9,613	7,700	2.4
	-4	1503	11,293	8,600	1.8
	77	1585	13,104	10,300	3.0
T88 MOD. 4	-42	1459	9,802	6,700	3.9
	-23	1467	9,385	7,400	1.9
	-4	1488	10,779	8,200	0.5
	77	1569	12,856	10,500	3.0
T88 MOD. 5	-42	1442	9,682	6,300	4.3
	-23	1488	9,547	7,400	2.3
	-4	1537	11,145	8,600	3.6
	77	1577	12,899	10,000	3.4

Notes:
1. Propellent 7 lb. 1 oz. PA30252
2. T137E3 rifle.
3. Non obturated test slugs.
4. Table values for modifications 1, 2, 3 and 4 of M57 are averages of three samples. All other table values are averages of five samples.

Evaluation of Rubber Obturators

Twenty T119E11 projectiles, with neoprene rubber "O" ring obturators were fired during the month of September at Erie Ordnance Depot. These projectiles were similar to the two rubber obturated projectiles described in the Thirty-Seventh Progress Report (Page 8). The purpose of the program was to check the accuracy, the uniformity of muzzle spin, and the terminal spin of a projectile of this type.

Spin Measurements

Four projectiles were fired through a system of seven yaw cards, placed so that four cards were within 169 ft. of the muzzle and three cards were between 2994 and 3014 ft. from the muzzle. One projectile struck the wood framework at 2994 ft. and no terminal spin was measured for this round. The range data are presented in Table V, the yaw card measurements of projectile rotation are listed in Table VI, a plot of rotation versus distance (near the muzzle) is given in Fig. 5 and a plot of rotation versus distance (in the vicinity of 3000 feet) appears in Fig. 6.

Projectile spin in revolutions per second was computed from the above plots. The values are listed in Table VII and a plot of spin versus distance down range is presented in Fig. 7.

The muzzle spin for these projectiles was more consistent than is usual for T119E11 projectiles. The spin of the four rubber obturated rounds varied from 9.1 to 12.1 rps with an average of 10.4 rps. The spread is 29% of the mean muzzle spin. For five T119E11 projectiles (Thirty-Fifth Progress Report) the spread was 44% of the mean muzzle spin.

The average spin at 3000 ft. for the rubber obturated projectiles was 10 rps which is in the same range as that measured on the unobutrated T119E11 projectiles. It was not expected that the terminal spin would be any greater despite the considerably higher muzzle spin which was intended, primarily, to reduce the time interval required for the projectile to reach the steady-state rolling velocity.

Table V
Range Data
To Measure Spin of T119 Projectile With Rubber Obturator

Test Conducted at Erie Ordnance Depot   Date of Test Sept 10, 1953   Purpose of Test Spin measurement of T119's w/Rubber Obturator

PROJECTILE
Model T119
Type EX
Weight 17.52 lb. (nom)
C.G. Location ____
Bourrelet Dia 4.132 -.002 in
Special Features Rubber "O" ring Obturator

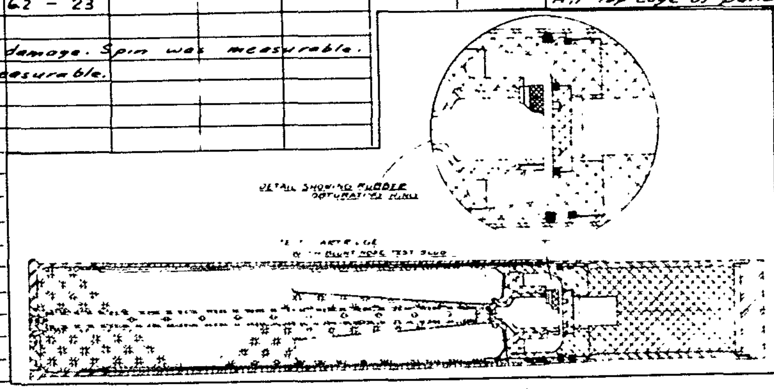
Gun — 70' 8" — 1 — 98' 3" — 2
Screen Distances

TEST GUN
Model T170E1/M40
Type 106mm recoilless
Serial No 61
Chamber F-23
Bushing (Vent) F 26
Tube 2265-115
Sighting Equipment Mount Telescope T183, #12
Mount
Type T149E3
Serial #14
Solenoid fired

MISCELLANEOUS DATA
Range 998 Yds
Propellant
Type M10MP Web .0335 in. Weight 7 lb. 1 oz.
Lot No PA 30252
Primer M57
Shell Case T53E1
Liner DRC-479-1
Temperatures
Magazine
Max 78°F. Min 70°F. Present 74°F.
Loading Room 76°F. Ambient 75°F.

Round No	Proj No.	Proj Weight (lb.)	Powder Charge (lb - oz)	Wind Vel & Dir	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Azim (mils)	Elevation (mils) zero – super	Position of Hit (mils) Vert	Position of Hit (mils) Horiz	Corrected Position of Hit — mils Vert	Corrected Position of Hit — mils Horiz	Recoil (in)	Observations
5813	X628	17.30	7 – 1	—	8300 8500	—	—	1½ L	62 – 24						To left – missed
5814	X616	17.30	7 – 1	—	9200 9100	—	—	0	62 – 24	+2	-1½				
5815	X623	17.30	7 – 1	—	8600 7700	—	—	0	62 – 23	+2	0				
5816	X617	17.29	7 – 1	—	8700 9600	1608	1637	0	62 – 22						Low – changed sights
5817	X609	17.30	7 – 1	—	9600 9400	1609	1638	0	62 – 24						Went between frame & target proper
5818	X1167	17.54	7 – 1	—	10100 9800	—	—	1½ R	62 – 23						Hit 2nd Coil, hit panel #3 at target
5819	X1170	17.54	7 – 1	—	9100 9000	—	—	1½ R	62 – 22						Hit panel #1 at target
5820	X1181	17.53	7 – 1	—	10100 9500	1606	1635	1½ R	62 – 22						Hit panel #1 at target
5821	X1168	17.54	7 – 1	—	7600 9200	1618	1647	1½ R	62 – 23						Hit top edge of panel #3 at target

Note: X1167 nicked velocity coil, but fins sustained no damage. Spin was measurable.
X1168 hit wood framework at target – spin not measurable.



Proof Director E. Huffman   Signed R.W. Faucon
Observers F. Mendez   L. Swoebly

Table VI
Yaw Card Measurements
T119E11 Projectile With Rubber Obturator

Card No.	Distance from Muzzle (feet)	Rotation (degrees)[a] Projectile			
		X1167	X1170	X1168	X1181
1	61.7	204.5	114.5	221.0	249.5
2	70.7	230.5	135.0	247.5	269.5
3	80.8	262.5	159.0	280.0	292.0
4	168.9	534.5	385.0	566.0	495.0
5	2994.0	319.0[b]	193.5[b]	c	276.0[b]
6	3004.5	363.5[b]	225.5[b]	c	300.0[b]
7	3013.2	404.5[b]	253.0[b]	c	319.0[b]

Notes:
a. Measured clockwise from horizontal reference line.
b. Add 360n, where n is number of revolutions relative to horizontal reference line on first card.
c. Projectile struck wood framework - rotation not measureable.

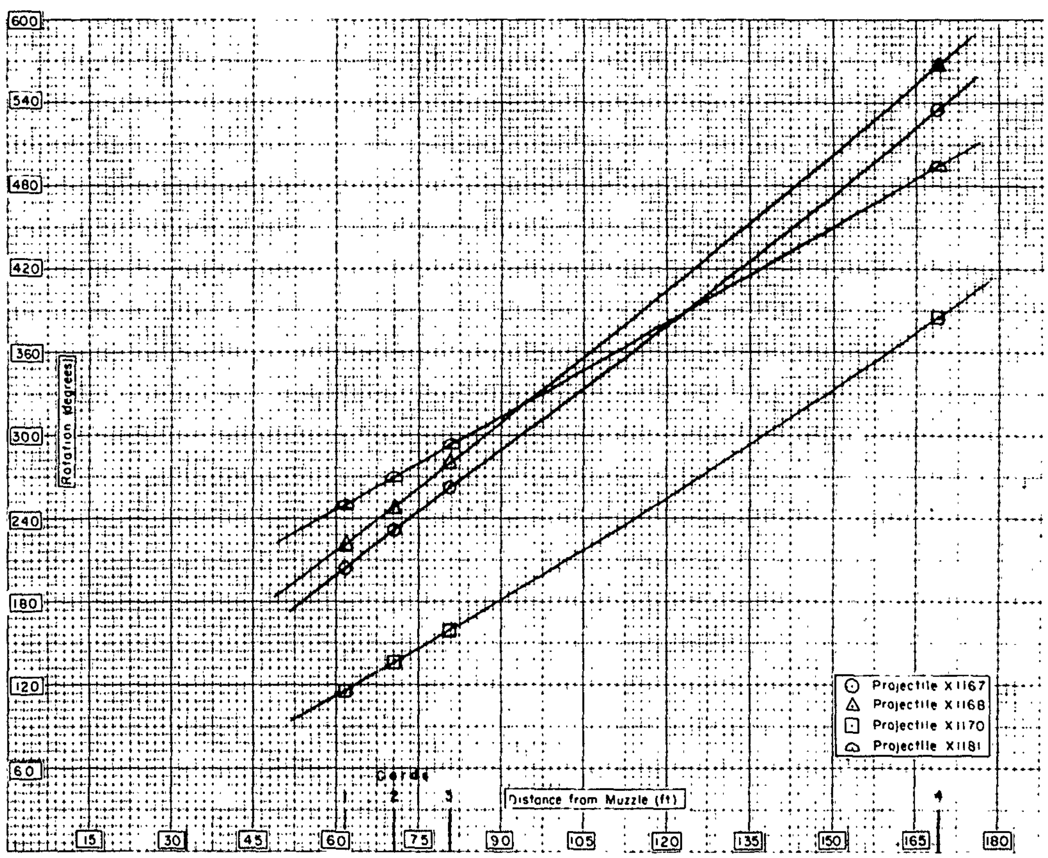


Fig. 5. Rotation Versus Distance From Muzzle (Meas. near Muzzle).
T119E11 Projectile With Rubber Obturator.

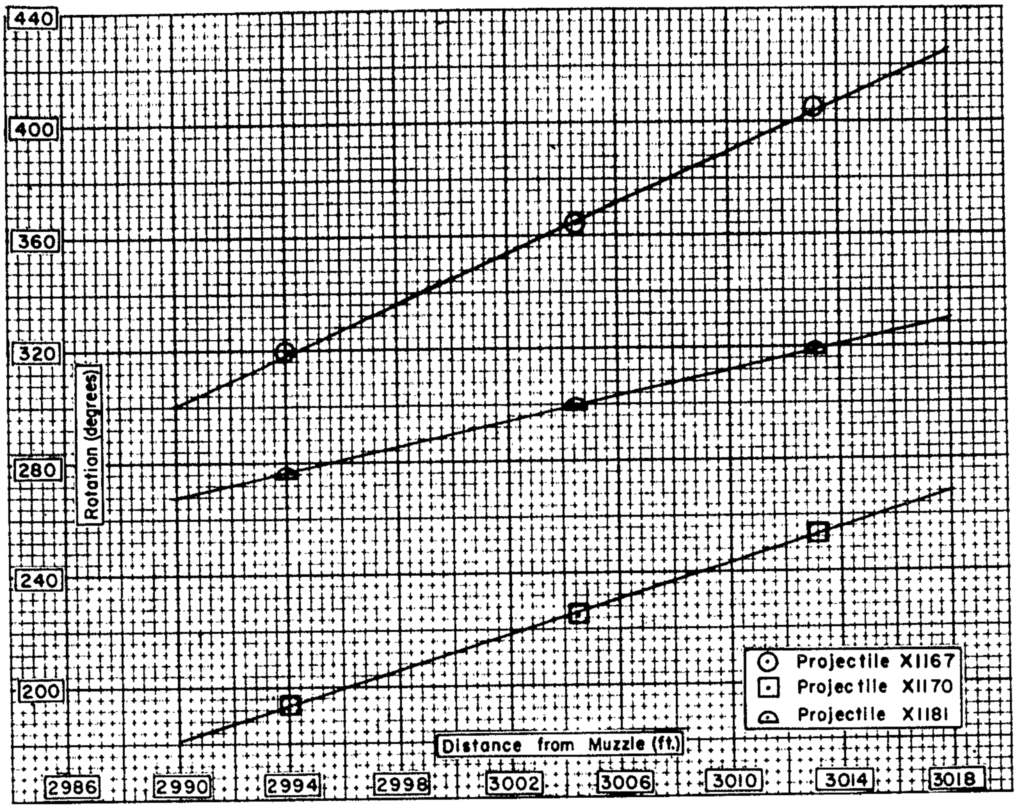


Fig. 6. Rotation Versus Distance From Muzzle (Meas. at Target).
T119E11 Projectile With Rubber Obturator.

Table VII
Spin Measurements
T119E11 Projectile With Rubber Obturator

Projectile No.		Distance from Muzzle (feet)						
		60	90	120	150	2994.0	3004.5	3013.2
X1167	Velocity (fps) [a] Rotation (deg/ft) Spin (rps)	1629.3 2.86 12.96	1623.5 2.96 13.35	1617.7 3.09 13.87	1611.9 3.18 14.25	1118.4 4.4 13.67	1117.2 4.4 13.65	1115.6 4.4 13.64
X1170	Velocity (fps) [a] Rotation (deg/ft) Spin (rps)	1629.3 2.34 10.59	1623.5 2.38 10.73	1617.7 2.51 11.28	1611.9 2.70 12.09	1118.4 3.1 9.63	1117.2 3.1 9.62	1115.6 3.1 9.61
X1168	Velocity (fps) Rotation (deg/ft) Spin (rps)	1635.3 2.95 13.40	1629.4 3.15 14.26	1623.5 3.24 14.61	1617.6 3.33 14.96	--- --- ---	--- --- ---	--- --- ---
X1181	Velocity (fps) Rotation (deg/ft) Spin (rps)	1623.3 2.22 10.01	1617.4 2.25 10.11	1611.5 2.29 10.25	1605.6 2.33 10.39	1113.9 2.2 6.81	1112.4 2.2 6.80	1111.3 2.2 6.79

Note:
a. No measured velocity available for these rounds. Average muzzle velocity of projectiles X1168 and X1181 used for these rounds.

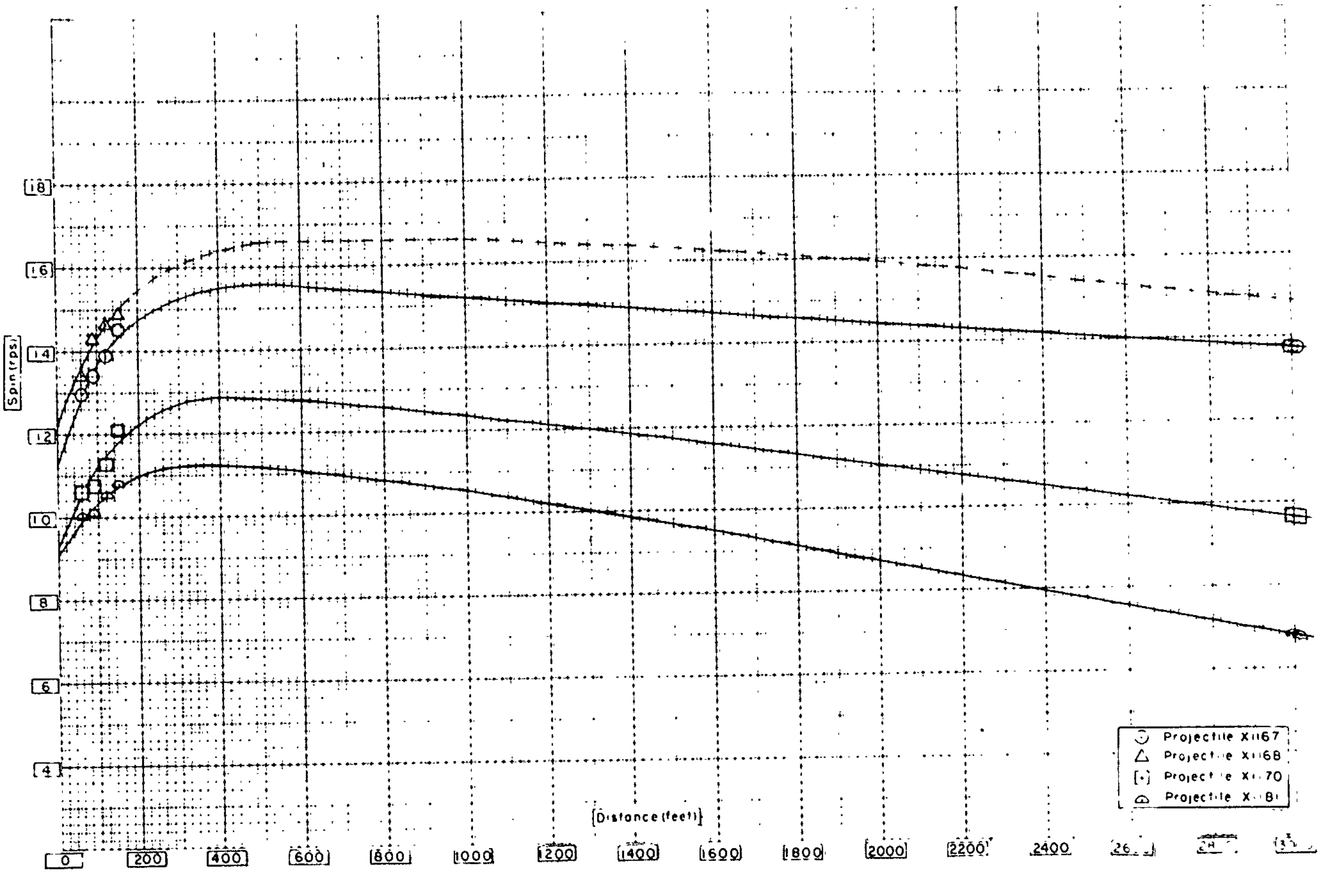


Fig. 7. Spin Versus Distance Down Range.
T119E11 Projectile With Rubber Obturator.

Accuracy

Sixteen T119E11 rubber obturated projectiles were fired in an accuracy comparison with a like number of unobturated T119E11 projectiles. The range data are presented in Table VIII. Two T119E11 projectiles were used to "range in" on an 18 ft. by 18 ft. target at 998 yards. Probable errors of dispersion for 14 impacts of the control group of T119E11 projectiles were ±.56 mil vertical and ±.47 mil horizontal. The 16 rubber obturated projectiles gave probable errors of dispersion of ±.40 mil vertical and ±.45 mil horizontal.

A comparison of the probable errors of dispersion for the two types of projectiles does not reveal a sufficient improvement to justify an immediate incorporation of the rubber "O" ring into the T119E11 projectile. However, the basic theory of improved accuracy and reduced erosion resulting from the use of such obturating rings appears sound and tests of rubber obturated projectiles are to be continued.

Table VIII
Accuracy Range Data
T119E11 Projectile With Rubber Obturator

Date of Test Sept 11, 1953

Purpose of Test Accuracy firing T119 EX & E11

Gun —— 70.54' —— 1 —— 98.67' —— 2

Screen Distances

PROJECTILE

Model T119
Type EX & E11
Weight 17.52 lb (nom)
C.G. Location
Bourrelet Dia
Special Features T119 EX w/rubber "O" ring obturator

TEST GUN

Model T170E1/M40
Type 106mm recoilless
Serial No 61
Chamber F-23
Bushing (Vent) F-26
Tube 22-C-511-5
Sighting Equipment Mt Telescope T183, #12
Mount
Type T149E3
Serial #14

MISCELLANEOUS DATA

Range 998 Yards
Propellant
Type M10MP Web .0335in Weight 7 lb 1 oz
Lot No PA 30252
Primer M57
Shell Case T53E1
Liner DRC545 4.65 oz./yd²
Temperatures
Magazine
Max 78°F Min 70°F Present 74°F
Loading Room 76°F Ambient 78°F

Round No	Projectile No.	Projectile Type	Powder Charge (lb-oz)	Wind Vel & Dir mph degrees	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Azim (mils)	Elevation (mils) zero	Elevation (mils) super	Position of Hit (inches) Vert	Position of Hit (inches) Horiz	Corrected Position of Hit — mils Vert	Corrected Position of Hit — mils Horiz	Yaw (in)	Observations
5822	426	E11	—	11.5 - 130	—	1572	1595	0	6.2	24	+36	-108	—	—	—	Hit 2x4's between top & middle.
5823	429	E11	—	8 - 140	—	1565	1588	+2			-5	-82	—	—	—	
5824	399	E11	—	11 - 140	8000 9400	1572	1595	+3			-28	+22½	-.779	+.626	—	
5825	X1177	EX	—	11.5 - 145	9600 10200	1587	1610	+3			+11½	+50	+.320	+1.392	—	
5826	432	E11	—	10 - 145	8600 8800	1571	1594	+3			+15	+23	+.418	+.640	4⅛ x 4⅜	
5827	X1171	EX	—	13 - 150	7800 9000	1583	1606	+3			+12½	-19½	+.348	-.543	—	Bore sight checked o.k.
5828	383	E11	—	7.5 - 145	9200 9600	1574	1597	+3			-49	+12	-1.364	+.334	—	
5829	X1178	EX	—	11 - 135	9400 9800	1585	1608	+3			-25½	+1	-.71	+.028	—	
5830	433	E11	—	12 - 125	—	1570	1593	+3			+8¼	+16½	+.23	+.459	—	
5831	X1182	EX	—	8.5 - 135	—	1570	1593	+3			-36	-11	-1.002	-.306	—	
5832	434	E11	—	9 - 160	—	1555	1578	+3			-17¾	+23¾	-.494	+.661	—	Bore sight checked o.k.
5833	X1185	EX	—	7.5 - 130	8800 9200	1589	1612	+3			-34	+27	-.946	+.752	—	
5834	423	E11	—	14.5 - 145	—	1564	1587	+3			-37	-14	-1.03	-.39	—	
5835	X1176	EX	—	12 - 155	8800 9600	1581	1604	+3		24.5	+27	+4½	+.252	+.125	—	
5836	436	E11	—	11.5 - 165	—	1557	1580	+2			-53	+10½	-1.975	+1.292	—	
5837	X1173	EX	—	11.5 - 150	—	1596	1619	+2			+1	-24½	-.472	+.318	—	Bore sight checked o.k.
5838	396	E11	—	15 - 145	8100 9000	1564	1587	+2			-13½	-23¾	-.876	+.339	—	
5839	X1179	EX	—	11.5 - 155	10000 8900	1580	1603	+2			-7½	+14¼	-.709	+1.397	4⅛ x 4½	
5840	422	E11	—	14 - 135	—	1559	1572	+2			-52½	-17¼	-1.961	+.520	—	
5841	X1175	EX	—	9 - 140	—	1574	1597	+2			-6	-7¾	-.667	+.784	—	Bore sight o.k.
5842	389	E11	—	15 - 140	—	1584	1607	+2			+39	0	+.586	+1.00	—	
5843	X1172	EX	—	14 - 140	—	1592	1615	+2			-3	+3¼	-.584	+1.090	—	Bore sight o.k. Use of quadrant discontinued.
5844	435	E11	—	12.5 - 155	9400 9000	1566	1589	+2			-28	+22½	-1.279	+1.626	—	
5845	X1180	EX	—	10 - 175	—	1580	1603	+1			-31	-53	-1.363	+.525	—	
5846	427	E11	—	18 - 155	8900 9000	1583	1606	+1			-33½	-22	-1.432	+1.388	—	

page 1 of 2

Table VIII (Cont.)

Date of Test Sept 11, 1953 Purpose of Test Accuracy Firing

Gun —70.54'— 1 —98.67'— 2
Screen Distances

PROJECTILE
Model T119
Type EX & E11
Weight 17.52 lb (nom.)
C.G. Location —
Bourrelet Dia 4.132 - .002 in.
Special Features T119EX w/rubber "O" ring obturator

TEST GUN
Model T170E1/M40
Type 106 mm recoilless
Serial No 61
Chamber F-23
Bushing (Vent) F-26
Tube 22 C-511-S
Sighting Equipment Mount Tel. T183, #12
Mount
Type T149E3
Serial #14

MISCELLANEOUS DATA
Range 998 Yards
Propellant
Type M10 MP Web .0335 in. Weight 7 lb. 1 oz.
Lot No PA 30252
Primer M57
Shell Case T53E1
Liner DRD 545, 4.65 oz/yd²
Temperatures
Magazine Max 78°F Min 70°F Present 74°F
Loading Room 76°F Ambient 78°F

Round No	Projectile No.	Projectile Type	Powder Charge (lb-oz)	Wind Vel & Dir mph degrees	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Azim (mils)	Elevation (mils) zero-super	Position of Hit (inches) Vert	Position of Hit (inches) Horiz	Corrected Position of Hit — mils Vert	Corrected Position of Hit — mils Horiz	Recoil (in)	Observations
5847	X1166	EX	—	10 - 150	—	1586	1609	+1	6.2 - 24.5	+1.00	-9 1/4	-.472	+1 742	—	Bore sight checked o k
5848	437	E11	—	15 - 160	—	1557	1598	+1	-	-38 1/2	-16	-1.572	+1.555	—	
5849	X1169	EX	—	14 - 150	—	1584	1607	0	-	+13	-60	-.138	+1 33	—	
5850	392	E11	—	14 - 180	9600 7600	1587	1610	0	-	-7	-23	-.695	+2 36	—	
5851	X1184	EX	—	9.5 - 195	8200 8400	—	—	0	-	-45	-73	-1753	+.968	—	
5852	X1183	EX	—	15 - 185	—	1583	1606	0	-	+21 1/2	-67	-.098	+1 136	—	
5853	X1174	EX	—	15 - 190	—	1603	1626	0	-	-9 1/2	-59 1/2	-.764	+1 344	—	

Note: No Quadrant seat was present on this rifle so a precision-ground steel bar was used as a seat on the chamber for the Quadrant. On several occasions the sight picture was not true to the quadrant readings although the bore sight was properly aligned. Since this phenomena was spasmodic, it was concluded that small bits of grit, or the heat of the chamber was affecting the quadrant readings.

Two target panels were loosened by projectiles striking the target, and were observed to hang at an angle to the firing line. Since it was only on these two panels that projectile profiles appeared to have an erratic yaw, the yaw measurements at the target were not taken.

Proj Type	Number	Center of Impact* (mils) Vert.	Center of Impact* (mils) Horiz	Probable Errors (mils) Vert	Probable Errors (mils) Horiz.
T119EX	16	-.04	+.76	±.40	±.45
T119E11	14	-.87	+.78	±.56	±.47

* Corrected to 24.5 mils elevation and +3 mils azimuth. Round no. 5822 and 5823 not used in P.E. Calculation

page 2 of 2

Proof Director E Huffman
Observers Dr Lucas, Dr Thurman
C. M. Cox

Cartridge Case Liner Development

As part of the test program to determine the optimum weight of rayon for the DRC 545 fabric-polyethylene laminated liner described in the Thirty-Second Progress Report, fifteen of this type liner with rayon weight of 3 oz. per sq. yd. were test fired in comparison with 15 DRC479-2 open sleeve type liners (T119E11 Cartridge Liner with rayon liners of 5.00 to 5.50 oz. per sq. yd.). See Tables IX and X.

The results indicate that the two liners differ only slightly in their effect upon interior ballistics when loaded with M5 propellent, web .040 Lot No. RAD16415; however, when used with M10 MP propellent, web .0335, the rounds using the new liner showed an increased muzzle velocity, a decreased pressure, and a slightly larger recoil than those using the standard DRC479-2 liner. The differences appear to be real, but the sample is small. The test data appear in Table XI.

The 3 oz. per sq. yd. weight of rayon has given the most consistent results of the various weights of rayon tested in the DRC545 laminated liner. It has also given ballistic results which are equal to, or better than, those of the sleeve type liner DRC479-2. The laminate does leave a small amount of unburned residue, but the amount of residue has not been harmful to gun operation. Therefore, it is believed that the DRC545 liner using a 3 oz. per sq. yd. weight of rayon could be incorporated satisfactorily into the present T119E11 cartridge. Tumbling tests of T119 E11 cartridge with this liner are scheduled for Picatinny Arsenal.

Future Program

1. Fifteen projectiles with short bodies, short ogives and rounded nose caps, have been assembled. It is planned to fire these projectiles to check drag and accuracy.

2. Twenty special housings having an O.D. of 4.118-.005 have been completed. Projectiles will be assembled with this component, and effect upon launching will be tested.

3. Projectiles with two rubber "O" ring obturators on the projectile chamber are being assembled. The uniformity of muzzle spin will be checked and an accuracy test will follow.

4. Nylon rotating bands are being tested in the T171 projectile program. If the performance of these bands is sufficiently interesting they will be tested further, using T119 projectiles.

Table IX
Range Data
Laminated Liner Test

Date of Test *July 30, 1953*

Purpose of Test *Laminated Liner Evaluation*
Test Conducted at Erie Ordnance Depot

Gun — 66.25' — 1 — 94.5' — 2
Screen Distances

PROJECTILE
Model *Test slug*
Type *DRC 510 Slug*
Weight *17.52.6 (nom)*
C.G. Location ——
Bourrelet Dia *4.132 - .002 in*
Ret Factor *0.4 ft/sec/ft*

TEST GUN
Model *T110E1/M40*
Type *106mm recoilless*
Serial No *50*
Chamber *2-K-1920-46*
Bushing (Vent) *F-34*
Tube *22-C-790-L*
Sighting Equipment *M17 Adapted Elbow Telescope*
Mount
Type *Pendulum*
Constant *2.11 lb-sec/in*

MISCELLANEOUS DATA
Range *Down range*
Propellant
Type *M10 MP* Web *.0335 in* Weight *7lb. 1¾ oz*
Lot No *PA 30252*
Primer *M-57*
Shell Case *T53E1*
Liner *DRC 479 2; DRC 545 (3oz/yd² rayon*
Temperatures
Magazine
Max *77°F* Min *71°F* Present *72°F*
Loading Room *85°F* Ambient *79°F*

Solenoid fired mechanically

Round No	Liner	Proj Weight (lb.)	Powder Charge (lb-oz)	Recoil (in)	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec		Depth* in Case	Azimuth (mils)	Position of Hit		Corrected Position of Hit — mils		Recoil (in)	Observations
						Instr	Actual			Vert	Horiz	Vert	Horiz		
5438	DRC 479 2	17.60	7-1¾	1½ F	10200 9000	1565	1610	¼							Chamber, Tube, & case clean
5439	DRC 479 2	17.60	7-1¾	1¼ F	10500 10200	1552	1597	0							" " " "
5440	DRC 479 2	17.62	7-1¾	1¼ F	9600 10300	1572	1617	0							Chamber & case clean. 6 pieces 1/16 x 1/8 in in tube
5441	DRC 479 2	17.60	7-1¾	1 R	9000 10300	1576	1621	0							Chamber tube & case clean
5442	DRC 479 2	17.60	7-1¾	1 F	9900 9100	1542	1587	0							" " " "
5443	DRC 545	17.62	7-1¾	¾ R	9300 9100	1630	1675	0							" " " "
5444	DRC 545	17.60	7-1¾	1½ F	9500 8800	1625	1670	0							2 pieces in tube ¾ x ⅜, ⅛ x ½ in, several v. small pieces
5445	DRC 545	17.60	7-1¾	3 F	10500 9800	—	—	0							Large pieces taken as samples, several small found
5446	DRC 545	17.60	7-1¾	3 F	8800 8100	1609	1654	¼							Large pieces taken as samples from chamber & case
5447	DRC 545	17.58	7-1¾	3¼ F	10200 9600	—	—	0							Sample from case, 4 pieces 1/8 x 1/8 in in chamber

*Depth that the bourrelet slipped or was pressed into case

Proof Director *E Huffman*
Observers *P Dacko*
W. Hopkins

Signed *O. Miller*

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Table X
Range Data
Laminated Liner Test

Date of Test *July 29, 1953*

Purpose of Test *Laminated Liner Test*
Fired at Erie Ordnance Depot

PROJECTILE

Model *Test slug*
Type *DRC-510*
Weight *17.52 lb (nom)*
C.G. Location —
Bourrelet Dia *4.132 -.002*

66.0' — 1 — 945' — 2
Screen Distances

TEST GUN

Model *T170E1/M40*
Type *106 mm recoilless*
Serial No *50*
Chamber *2-K-1920-46*
Bushing (Vent) *F34*
Tube *22-C-790-L*
Sighting Equipment *M-17 Adapted Elbow Telescope*
Mount
Type *Pendulum*
Constant *2.11 lb.-sec/in.*
Solenoid Mechanical Firing System

MISCELLANEOUS DATA

Range *Down Range*
Propellant
Type *M-5 MP* Web *.040 in.* Weight *7 lb 4½ oz*
Lot No *RAD 16415*
Primer *M-57*
Shell Case *T-52*
Liner *DRC-479-2 & DRC-545 (3.0 oz/yd² rayon*
Temperatures
Magazine
Max *77°F* Min *71°F* Present *78°F*
Loading Room *88°F* Ambient *90°F*

* *Internal M3*

Round No	Recoil (in.)	Proj Weight (lb.)	Powder Charge (lb-oz)	Liner	Chamber Pressure* (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Elev (mils)	Azimuth (mils)	Position of Hit Vert	Position of Hit Horiz	Observations
5418	2 R	17.62	7 - 4½	DRC-479-2	7200 9500	1604	1649					Tube, chamber & case clean
5419	0	17.60	7 4½	"	9000 8500	1602	1647					" " " "
5420	1¾ R	17.62	7 4½	"	8400 9000	1612	1657					" " " "
5421	4 R	17.60	7 4½	"	9100 9000	1616	1661					" " " "
5422	0	17.62	7 4½	"	8100 9200	1556	1601					" " " "
5423	3½ R	17.56	7 4½	"	8200 9700	1627	1672					" " " "
5424	½ R	17.58	7 4½	"	8600 7600	1621	1666					" " " "
5425	1½ R	17.61	7 4½	"	8800 8600	1585	1630					" " " "
5426	1 F	17.61	7 4½	"	7800 8200	1609	1654					" " " "
5427	1 R	17.63	7 4½	"	9200 9800	1592	1637					" " " "
5428	0	17.51	7 4½	DRC-545	8700 8800	1606	1651					1 piece ¼ x ¾ in case, 4 small pieces in tube
5429	2 R	17.60	7 4½	"	7200 7400	1573	1618					
5430	2 F	17.56	7 4½	"	8500 7900	1590	1635					2 pieces, 1¼ x ½ & ¾ x ¼ in tube, chamber & case clean.
5431	¾ R	17.60	7 4½	"	7900 8300	—	—					2 pieces, ¼ x ⅛, in case, small amt. polyethylene deposited outside case; chamber & case clean.
5432	2 R	17.62	7 4½	"	8300 9200	—	—					3 pieces ¼ x ½, 2 - ⅛ x ⅛ in case; tube & chamber clean.
5433	2 R	17.62	7 4½	"	8700 7900	1595	1640					Small amt polyethylene deposited outside case, tube & chamber clean
5434	2¾ R	17.54	7 4½	"	8200 9500	1606	1651					1 piece ¼ x ½ in case, tube & chamber clean
5435	2¼ R	17.63	7 4½	"	9400 9500	1715	1760					4 very small particles in tube; chamber & case clean
5436	0	17.50	7 4½	"	9500 9800	1675	1720					Tube, chamber & case clean.
5437	½	17.52	7 4½	"	9600 8300	1611	1656					Note: Blast switch #4 functioned on all rounds
							Recoil					Pieces had polyethylene burned off, only rayon left
					Avg	Avg	Avg					All rounds loaded and fired as single units.
				DRC-479-2	8680	1647	1.3 R					
				DRC-545	8400**	1642**	1.1 R x					

** Omitting rounds 5435 & 5436
x Omitting rounds 5435, 5436 & 5437

Proof Director *E. Huffman* Signed *O. Miller*
Observers *C. Engebretsen*

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Table XI
Effect of Liners on Interior Ballistics
DRC545 and DRC479-2 Liners
Propellent Lot RAD16415

Round No. [d]	Type Liner	Powder Charge (lb – oz.)	Pressure Internal Copper (psi)	Velocity (fps)	Recoil (in.)
Propellent Lot RAD16415 [a]					
5418	DRC479-2	7-4 1/2	7200 9500	1649	2R
5419	"	"	9000 8500	1647	0
5420	"	"	8400 9000	1657	1 3/4 R
5421	"	"	9100 9000	1661	4R
5422	"	"	8100 9200	1601	0
5423	"	"	8200 9700	1672	3 1/2 R
5424	"	"	8600 7600	1666	1/2 R
5425	"	"	8800 8600	1630	1 1/2 R
5426	"	"	7800 8200	1654	1 F
5427	"	"	9200 9800	1637	1 R
		Average	8680	1647	1.3R
5428	DRC545	7-4 1/2	8700 8800	1651	0
5429	"	"	7200 7400	1618	2R
5430	"	"	8500 7900	1635	--
5431	"	"	7900 8300	--	3/4 R
5432	"	"	8300 9200	--	2R
5433	"	"	8700 7900	1640	2R
5434	"	"	8200 9500	1651	2-3/4 R
5437 [c]	DRC545	7-4 1/2	9600 8300	1656	--
		Average	8400	1642	1.1 R
Propellent Lot PA30252 [b]					
5438	DRC479-2	7-1 3/4	10200 9000	1610	1 1/2F
5439	"	"	10500 10200	1597	1 1/4F
5440	"	"	9600 10300	1617	1 1/4F
5441	"	"	9000 10300	1621	1R
5442	"	"	9900 9100	1587	1F
		Average	9810	1606	0.8F
5443	DRC545	7- 1 3/4	9300 9100	1675	3/4R
5444	"	"	9500 8800	1670	1 1/2F
5445	"	"	10500 9800	--	3F
5446	"	"	8800 8100	1654	3F
5447	"	"	10200 9600	--	3 1/4F
		Average	9380	1667	2F

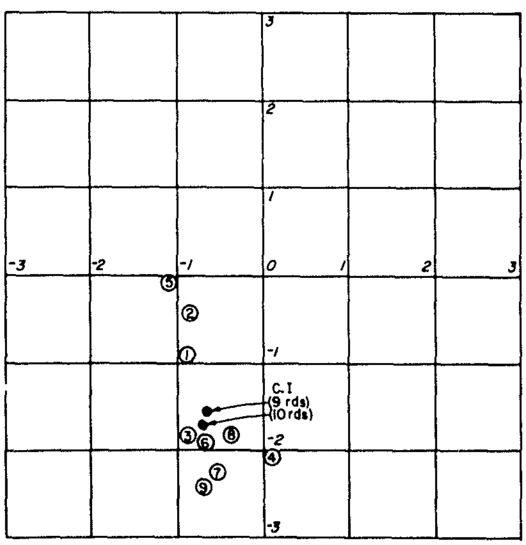
Notes:
1. a. Lot RAD 16415 - M5MP .040 WEB
   b. Lot PA30252 - M10MP .038 WEB
   c. Rounds 5435 and 5436 omitted because of questionable charge.
   d. DRC-510 slugs used on all rounds.

Accuracy Firing With T171MD10 Projectiles

The accuracy of the T171 MD10 projectile without rotating band, when fired from a T137E2 rifle with a 1/20 twist tube, was presented in the Thirty-Seventh Progress Report. Eleven of twelve rounds hit the target with horizontal and vertical probable errors of ±.60 mil and ±.90 mil, respectively. Ten additional T171MD10 projectiles fitted with rotating bands have now been fired from a 1/500 twist tube (10 rps at 1700 fps) in order to determine whether an increased spin rate and good obturation would improve the accuracy of this projectile. Nine of the ten projectiles struck the target with an horizontal probable error of ±.23 mil and a vertical probable error of ±.55 mil. These rounds were fired at an elevation of 23.5 mils and zero azimuth at a muzzle velocity of 1666 fps. The center of impact was 1.53 mils below and .66 mil left of the aiming point. The target hits are shown in Figure 8 and the firing record is shown in Table XII.

The one round that missed the target struck the ground 200 in. behind the target and 30 in. left of the target center. From time of flight data and muzzle velocity data for rounds 1 and 4, a ballistic coefficient was determined, the angle of fall was computed and the projectile height at the target was estimated. The calculated point of impact for this round is shown in Fig. 8 along with the other impact points and it is apparent that its flight is not different from the others. When these data are included the probable errors become: H.P.E. ±.21 mil and V.P.E. ±.64 mil.

It is quite evident that the increased muzzle spin and the better obturation have improved the accuracy of the T171MD10 greatly although the vertical dispersion still seems greater than can be accounted for on the basis of the variations in muzzle velocity. The tests are to be continued using various spin inducers and a 1/20 twist tube and are to be extended to the T171MD11 projectile also. Various possible causes for the magnitude of the vertical dispersion are being investigated. Typical examples include gun jump, variable air density and variable recoil.



⑩ Estimated Position (See Text)

Probable Error (mils) (9 rds.)	(10 rds.)
H.P.E. = ±.23	H.P.E. = ±.21
V.P.E. = ±.55	V.P.E. = ±.64

Center of Impact (9 rds.)	(10 rds.)
H.C.I. = -.66	H.C.I. = -.68
V.C.I. = -1.53	V.C.I. = -1.74

Fig. 8. T171MD10 Dispersion Chart.
1000-Yard Range; 23.5 Mils Elevation; 1-500 Tube.

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Table XII
Range Data
T171MD10 Projectile

Date of Test Sept 23, 1953

Purpose of Test Accuracy of T171MD10
Test Conducted at Erie Ordnance Depot

PROJECTILE

Model T171
Type MD10
Weight 17.5 lbs (nom)
CG Location
Bourrelet Dia 4.132 − .002 in

Coil Distances

Gun — 70.8" — 1 — 98.5 — 2 — 32.8 — 3 — 56 — 4

TEST GUN

Model T37E3
Type [illegible]
Serial No 3
Chamber 22 H 64 L B
Bushing (Vent) 22 C 155 K
Tube 22 G 5065, 1/500
Sighting Equipment Mount Telescope T183 #9
Mount
Type T52E4
Serial 13

MISCELLANEOUS DATA

Range 998 Yds
Propellant
Type M5MP Web .040 in Weight 8 lb 0 oz
Lot No RAD 16415
Primer M57
Shell Case T6 cut down
Liner T6
Temperatures
Magazine
Max 77°F Min 72°F Present 75°F
Loading Room 69°F Ambient 60°F

Solenoid fired

Round No	Proj No	Proj Weight (lb.)	Piezo Pressure (psi)	Wind Vel & Dir mph - degrees	Chamber Pressure (lb/sq in) M3 Internal (Cu)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Azim (mils)	Elevation (mils) Zero - Super	Position of Hit (inches) Vert	Position of Hit (inches) Horiz	Corrected Position of Hit — mils Vert	Corrected Position of Hit — mils Horiz	Retardation ft/sec/ft	Yaw at Target (in.)	Observations
5908	1157	17.52	—	2 - 030	8000 8300	1634	1658	0	48 - 22[illegible]	-71	-31½	-976	-.877	—	4⅛ x 4¼	Good Flight
5909	1151	17.46	—	2 - 015	8900 8200	1656	1680	0	48 - 22[illegible]	-53¾	-28½	-496	-.793	.1939	4⅛ x 4⅛	" "
5910	1159	[illegible]46	10,413	2 - 020	8200 9000	[illegible]	1659	0	[illegible] - 230	-84	-32	-1838	-.891	.2229	4 5/16 x 4⅛	" "
5911	1152	17.50	10,588	2 - 010	9100 8100	1643	1667	0	4[illegible] - 230	-91½	+2½	-2046	+.070	2230	4¾ x 4⅛	" "
5912	1158	17.46	10,940	5 - 040	87[illegible] 9400	—	—	0	48 - 235	-3¾	-39½	-.104	-1099	—	4½ x 4 1/16	" "
5913	1156	17.50	10,835	5 - 030	8500 —	1634	1658	0	48 - 235	-67.4	-25½	-1872	-.710	.2095	4¼ x 4⅛	" "
5914	1153	17.51	10,796	5 - 045	8400 8500	1635	1659	0	48 - 235	-81	-19½	-2254	-.543	.2145	4 5/16 x 4¼	" "
5915	1154	17.48	—	4 - 030	8000 9[illegible]	x1625	1671	0	48 - 235	-65	-13	1809	-.362	—	4¼ x 4⅛	" "
5916	1155	17.50	10,241	5 - 050	7100 8600	1643	1667	0	48 - 235	-86½	-35½	-2407	-.710	.1981	4½ x 4 1/16	" "
5917	1150	17.46	10,325	5 - 030	8300 —	1641	1665	0	48 - 23[illegible]	—	-31	—	-.863	.2257	—	" " , hit below target

Note: Target 28° clockwise from Magnetic North, and measured clockwise from Mag N.
One mil = 3593 in at 998 yds. Time of flight round no 5908 = 2.26488, round no 5911 = 2.27887
x Instrument velocity at 3rd & 4th coils

	Avg	
Piezo Pressure	10,591	psi
Chamber (M3) Press	8477	psi
Muzzle Velocity	1663	fps
Retardation	.2125	fsf
Projectile Wgt	17.49	lb

Center of impact V = −1534; H = −.651
Probable Error — Vertical ±.547
Probable Error — Horizontal ±.233
By RMS

Proof Director E Huffman
Observers [illegible]
L Swaebly

Signed R.W. Finucan

CONFIDENTIAL

Future Program

1. T171MD10 projectiles are to be tested for accuracy from 1/20 twist tube using various spin inducers.

2. T171MD10 projectiles are to be tested for accuracy when inserted into the shell case up to a point just aft of the rotating band. In present tests the projectile is not inserted into the case.

3. T171MD11 projectiles are to be tested for accuracy when launched at 10 rps from a 1/500 twist rifled tube.

4. Make measurements of the density of the air as a function of flight time so as to obtain more reliable ballistic data.

PENETRATION STUDIES

Mild Steel Versus Homogeneous Armor

Mild steel plate, because of availability and relatively low cost, is convenient to use as target material even though the ultimate target to be defeated will be homogeneous armor plate. It is, therefore, necessary to establish the penetration equivalents of mild steel and homogeneous armor plate.

During the early days of the BAT program, while Firestone and the Ballistic Research Laboratories were jointly investigating the penetration behavior of the T138 type, slow spin projectile, a large quantity of steel plate, reported to be homogeneous armor plate, was used as target material. When penetrations seemed high the hardness of the plate was measured, and found to be BHN 220-230 instead of the usual BHN 310-320 of homogeneous armor plate. A comparison of the penetration resistance of mild steel and regular target material (of homogeneous armor chemical composition but now identified as "green armor") was made and is reported in the Fifth Progress Report. Penetrations into homogeneous armor were 14% less than into the green armor at zero rps and 12% less at 45 rps. A comparison between homogeneous armor plate and mild steel at 25 rps was made at the Erie Ordnance Depot and is reported in the Thirteenth Progress Report. The penetration into this armor was only 5% less than into mild steel. When measured, the BHN's of the armor plate and the mild steel were found to be 260-275 and 110-130, respectively.

The penetration of a wide variety of types and sizes of charges into mild steel and homogeneous armor plate was reported in the OSRD Report No. 5604. The relationship between depth of penetration into these two target materials was found to be linear with approximately 16% less penetration into armor plate than into mild steel.

Because of the importance of knowing this relationship for a variety of standoff conditions and spin rates, these studies are being extended. As a first part of this study penetrations into mild steel and homogeneous armor plate have been determined using DRC376 test assemblies and DRB398 HW3 item 1 copper cones fired at 7.5 inches standoff and zero rps. A quantity of homogeneous armor plate was obtained of which the BHN was found to be low and variable ranging from approximately 200 to 240. A portion of this armor was heat treated to BHN 290 to 310. Comparative penetrations into mild steel, armor "as received" and armor "heat treated" were measured.

The inspection data for the cones are shown in Table XIII. The target plate hardness test results are shown in Table XIV. The penetration data are shown in Table XV and Fig. 9. Fig. 10 is an extension of the plot of penetration into homogeneous armor versus mild steel found in the OSRD Report No. 5604. The early linear relationship between penetrations into mild steel and homogeneous armor fits the present data for the heat treated armor quite well. Fig. 9, a plot of penetration versus Brinell Hardness Number, shows a progressive decrease in penetration as the hardness of the target increases. The relationship between penetration and target hardness is linear over the hardness range covered.

The average penetration into mild steel (BHN 110-117) was 11% greater than into "as received" armor (BHN 230-245) and 19% greater than into the heat treated armor plate (BHN 290-310). Therefore, the armor plate used in the remaining portion of the study will be heat treated to BHN 300-310.

Table XIII
Inspection Data
DRB398 HW3 Item 1, Smooth Copper Cones

Cone Number	Wall Thickness (inches)			Max. Wall Thickness Variation (inch)		Max. Wall Waviness (inch)		Concentricity[1,2]		
	Max.	Min.	Avg.	Transverse	Longitud.	O. D.	I. D.	Base Datum	Apex Datum	Cone Tip in Assembly
Specification DRB398 HW3	.105	.100	----	.002	.006	.006	.006	.003	.003	.015 (Nominal)
FS1158	.107	.097	.0996	.001	.006	.002	.006	.004	.004	.012
FS1159	.103	.096	.0997	.001	.007	.002	.007	.002	.001	.008
FS1160	.102	.095	.0985	<.001	.007	.003	.005	.003	.003	.006
FS1161	.099	.092	.0958	.001	.007	.002	.004	.005	.005	.003
FS1162	.106	.095	.1006	.001	.006	.002	.007	.004	.004	.009
FS1163	.101	.094	.0976	.001	.007	.003	.004	.004	.004	.006
FS1164	.104	.095	.0996	.001	.009	.002	.006	.003	.004	.008
FS1165	.106	.095	.1005	.001	.010	.002	.006	.004	.004	.008
FS1166	.106	.095	.1002	.001	.011	.002	.006	.003	.003	.002
FS1167	.105	.096	.1006	.001	.008	<.001	.006	.004	.004	.004
FS1168	.105	.094	.0998	.001	.010	.002	.008	.001	.003	.007
FS1169	.103	.095	.0993	.001	.008	.002	.004	.002	.002	.011
FS1170	.102	.094	.0983	.001	.008	.002	.005	.006	.003	.006
FS1171	.102	.095	.0985	.001	.007	.002	.004	.004	.001	.008
FS1172	.106	.094	.1004	.001	.012	.002	.008	.002	.003	.004
Avg.	.1038	.0948	.0993	.0010	.0082	.0020	.0057	.0034	.0032	.0068
Std. Dev.	±.0023	±.0012	±.0013	--	±.0018	±.0007	±.0014	±.0013	±.0012	±.0028

Notes:
1. Base datum is .484 inch above base; apex datum is 3.202 above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liner's axis.

Table XIV
Target Plate Hardness
Test Results

Group No.	Round No.	Target Material	Brinell Hardness	B.H.N. for Stack (Avg.)
1	FS1158	HEAT TREATED ARMOR	302	
		"	321	
		"	340	
		"	302	
		"	293	
		"	302	
		"	302	309.0
1	FS1159	"	286	
		"	302	
		"	286	
		"	302	
		"	302	
		"	321	
		"	302	300.0

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Table XIV (Cont.)

Group No.	Round No.	Target Material	Brinell Hardness	B.H.N. for Stack (Avg.)
1	FS1160	HEAT TREATED ARMOR	302	
			302	
		"	286	
		"	302	
		"	311	
		"	321	
		"	302	303.7
1	FS1161	"	286	
		"	302	
		"	302	
		"	302	
		"	302	
		"	286	
		"	321	300.0
1	FS1162	"	302	
		"	302	
		"	321	
		"	302	
		"	302	
		"	321	
		"	321	310.0
2	FS1163	"	235	
		"	274	
		"	257	
		"	235	
		"	220	
		"	232	
		"	255	244.0
2	FS1164	"	220	
		"	244	
		"	242	
		"	221	
		"	208	
		"	221	
		"	251	229.6
2	FS1165	"	243	
		"	251	
		"	251	
		"	235	
		"	251	
		"	221	
		"	245	242.4
2	FS1166	"	206	
		"	235	
		"	266	
		"	266	
		"	235	
		"	251	
		"	243	243.1
2	FS1167	"	266	
		"	235	
		"	250	
		"	251	
		"	235	
		"	224	
	Cont'd Next Page	"	252	244.7

Table XIV (Cont.)

Group No.	Round No.	Target Material	Brinell Hardness	B.H.N. for Stack (Avg.)
3	FS1168	MILD STEEL	123	
		"	117	
		"	111	
		"	108	
		"	133	
		"	110	
		"	116	
		"	120	117.2
3	FS1169	"	108	
		"	114	
		"	111	
		"	108	
		"	116	
		"	114	
		"	116	
			114	112.6
3	FS1170	"	110	
		"	107	
		"	114	
		"	120	
		"	120	
		"	117	
		"	124	
		"	114	115.7
3	FS1171	"	120	
		"	114	
		"	110	
		"	107	
		"	107	
		"	107	
		"	114	112.4
3	FS1172	"	106	
		"	107	
		"	114	
		"	116	
		"	110	
		"	110	
		"	116	
		"	102	110.1

Table XV
Penetration Data
Comparative Penetrations
Into Mild Steel, Homogeneous Armor and Heat Treated Homogeneous Armor

Round No	Comp. B (lbs.)	Target Material	Brinell Hardness No. (Avg.)	Penetration (in.)	Max. Spread (in.)	Std. Dev (in.)
FS1158	2.46	Homo. Armor Heat Treated	309	19.00		
FS1159	2.44	"	300	18.75		
FS1160	2.46	"	304	18.06		
FS1161	2.46	"	300	17.56		
FS1162	2.46	"	310	17.81		
			Avg.	18.24	1.44	±.62
FS1163	2.44	Homo. Armor As Rec'd.	244	19.44		
FS1164	2.46		230	19.62		
FS1165	2.44	"	245	20.06		
FS1166	2.44	"	243	20.12		
FS1167	2.46	"	245	20.81		
			Avg.	20.01	1.37	±.53
FS1168	2.46	Mild Steel	117	22.00		
FS1169	2.48	"	112	22.44		
FS1170	2.46	"	116	21.56		
FS1171	2.46	"	112	22.69		
FS1172	2.46	"	110	23.25		
			Avg.	22.39	1.69	±.65

Notes:
1. Cones were recoined, copper DRB398 HW3 item 1, assembled in DRC376 test assemblies, base plugs and No. 2 nose rings.
2. Loaded at Ravenna Arsenal, BAT Lot No. 32, with Composition B from Holston Lot No. 4-1197.
3. Tested at Erie Ordnance Depot at 7.5 inch standoff and 0 rps.

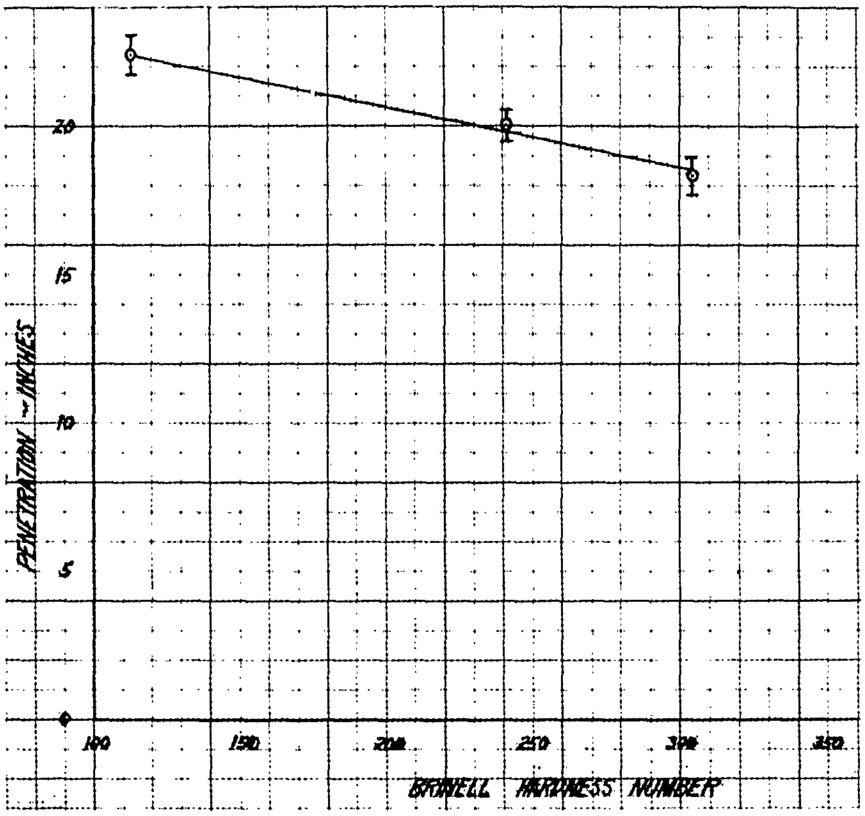

Fig. 9. Penetration Versus Brinell Hardness Number.

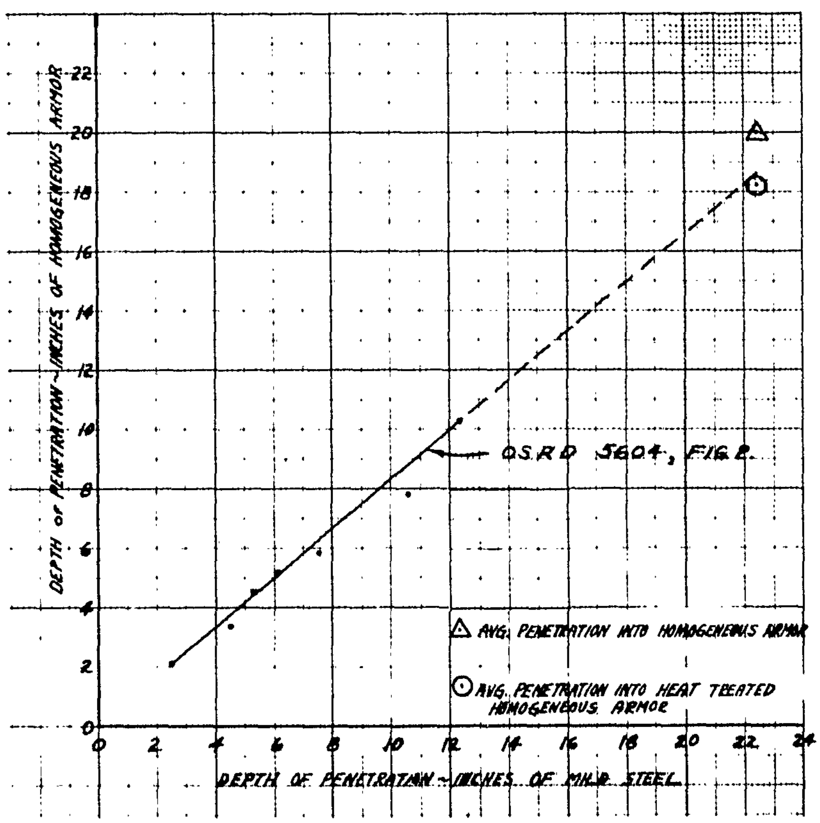

Fig. 10. Penetrations Into Homogeneous Armor
Versus
Penetrations Into Mild Steel.

Comparison of Penetration Results Of "Long" and "Short" T119 Bodies With DRC376 Test Bodies; and T119E11 Ogive With DRC376 Nose Ring

This test was designed to compare the penetration of DRB398-9 copper cones when assembled in; (1) T119E11 projectiles, (2) T119E11 projectiles with shortened bodies, (3) DRC-376 test bodies with T119E11 ogives and (4) DRC376 test assemblies with No. 1 nose rings. Fig. 11 shows the various modifications tested. Cone inspection data are shown in Table XVI and penetration data in Table XVII. A summary of the findings is shown below:

	Penetration–in. M S 0 rps	15rps
T119E11 Short Body	20.66 ± 1.82	19.79 ± .52
T119E11 Long Body	20.94 ± .88	19.84 ± .74
DRC376 With Ogive	20.93 ± 1.07	20.53 ± .27
DRC376 No. 1 Ring	20.63 ± 1.31	18.96 ± .87

The standard T119E11 body (DRC497-long body) is longer by .63 in. than the short body (DRC546) and contained about .38 lb. more Composition B, but did not show any improved penetration behavior at 0 or 15 rps. The penetration loss due to a rotation of 15 rps amounted to 5% and agrees with the loss to be expected as determined from Fig. 31 of the Thirty-Sixth Progress Report.

The DRC565 ogive and DRA699 cap do not reduce the penetration significantly at 0 rps. At 15 rps the penetration of the round containing the DRC565 ogive and DRA699 cap was actually somewhat higher than the round containing the DRC376 No. 1 nose ring although the difference was not large enough to have significance.

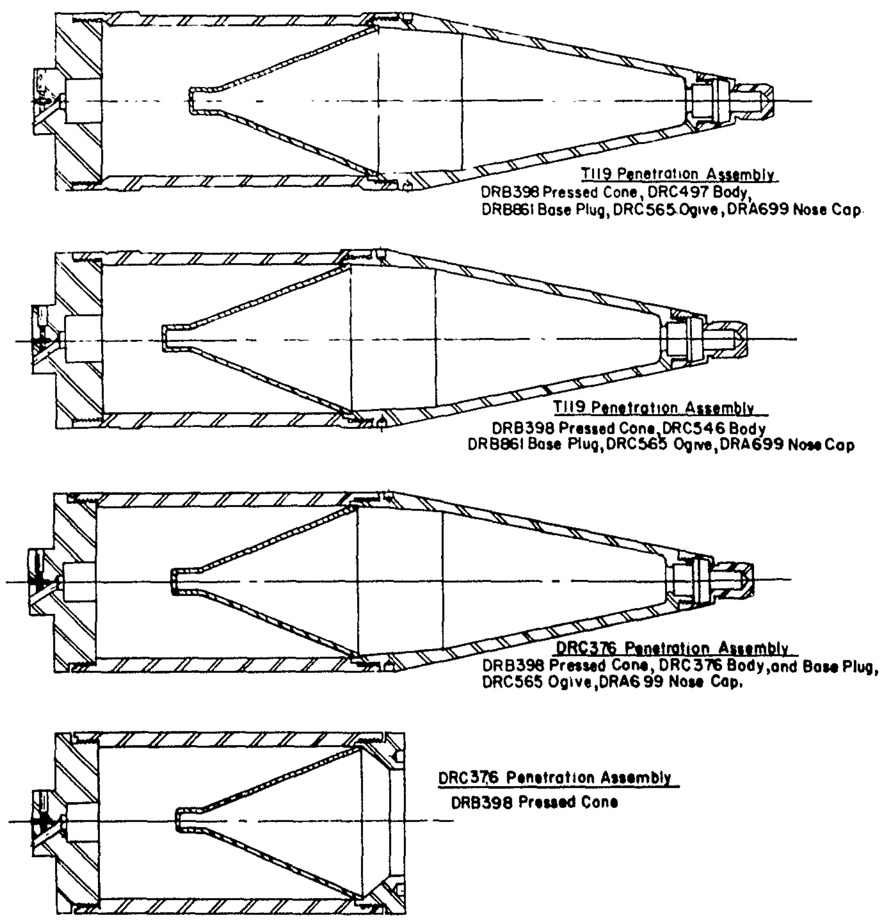

Fig. 11. Penetration Test Assemblies.
See Table XVII.

Table XVI
Inspection Data
DRB398-9 Drawn Copper Cones

Cone Number	Wall Thickness inches Max.	Wall Thickness inches Min.	Wall Thickness inches Avg.	Max. Wall Thickness Variation-in. Transv.	Max. Wall Thickness Variation-in. Longitud.	Max. Wall Waviness-in. O.D.	Max. Wall Waviness-in. I.D.	Concentricity[1,2] Base Datum	Concentricity[1,2] Apex Datum	Concentricity[1,2] Spitback Tube in Assembly
Specification DRB 398 Cone	.105	.100		.002	.006	.006	.006	.003	.003	(Nominal) .015
R826	.101	.100	.1006	.001	.001	.002	.006	.005	.006	.009
R827	.102	.100	.1003	.001	.002	.002	.003	.003	.005	.005
R828	.101	.100	.1002	.001	.001	.002	.005	.005	.005	.005
R829	.101	.100	.1004	.001	.001	.002	.005	.003	.002	.003
R830	.101	.100	.1004	.001	.001	.002	.004	.003	.005	.009
R831	.103	.101	.1017	.002	.001	.002	.004	.005	.004	.005
R832	.102	.100	.1013	.001	.002	.002	.004	.007	.005	.008
R833	.101	.100	.1004	.001	.001	.002	.004	.004	.005	.007
R834	.101	.100	.1001	.001	.001	.002	.003	.003	.004	.009
R835	.101	.100	.1004	.001	.001	.002	.003	.006	.009	.008
R836	.103	.101	.1021	.002	.001	.002	.003	.004	.005	.008
R837	.101	.100	.1006	.001	.001	.002	.004	.003	.009	.010
R838	.102	.101	.1016	.001	.001	.002	.003	.005	.006	.006
R839	.101	.101	.1010	<.001	<.001	.002	.003	.004	.008	.009
R840	.103	.102	.1020	.001	.001	.002	.004	.003	.005	.010
R841	.102	.100	.1006	.002	.001	.005	.005	.003	.005	.006
R842	.101	.100	.1005	.001	.001	.004	.003	.005	.004	.007
R843	.103	.102	.1026	.001	.001	.009	.005	.006	.005	.009
R844	.101	.100	.1005	.001	.001	.005	.002	.003	.005	.006
R845	.102	.100	.1008	.002	.002	.004	.002	.004	.005	.011
R846	.102	.100	.1010	.002	.001	.004	.004	.003	.005	.008
R847	.101	.100	.1003	.001	.001	.003	.003	.003	.004	.006
R848	.104	.103	.1031	.001	.001	.003	.003	.005	.009	.016
R849	.102	.100	.1013	.001	.002	.005	.003	.006	.008	.009
R850	.102	.101	.1018	.001	.001	.007	.003	.005	.005	.003
R851	.103	.101	.1020	.001	.001	.004	.003	.005	.008	.008
R852	.105	.104	.1046	.001	.001	.007	.003	.004	.005	.010
R853	.102	.102	.1020	<.001	<.001	.004	.002	.004	.009	.009
R854	.104	.103	.1034	.001	.001	.003	.003	.003	.007	.009
R855	.102	.101	.1016	.001	.001	.004	.004	.006	.006	.010
R856	.101	.100	.1004	.001	.001	.003	.003	.002	.003	.004
R857	.100	.099	.0996	.001	.001	.004	.004	.003	.005	.014
R858	.103	.100	.1013	.001	.002	.005	.004	.002	.004	.015
R859	.102	.100	.1011	.002	.001	.004	.003	.006	.008	.017
R860	.104	.103	.1035	.001	.001	.004	.006	.003	.006	.015
R861	.103	.101	.1019	.001	.002	.005	.004	.003	.005	.011
R862	.101	.100	.1006	.001	.001	.005	.004	.004	.005	.018
R863	.102	.101	.1016	.001	.001	.004	.004	.005	.005	.009
R864	.102	.101	.1011	.001	.001	.005	.002	.004	.005	.010
R865	.103	.100	.1020	.002	.002	.004	.003	.003	.004	.019
Avg.	.1020	.1007	.1013	.0011	.0011	.0036	.0036	.0041	.0056	.0093
Std. Dev.	±.0011	±.0011	±.0010	±.0005	±.0005	±.0016	±.0010	±.0012	±.0017	±.0039

Notes:
1. Base datum is .484 inch above base; apex datum is 3.202 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liner axis.

Table XVII
Penetration Data
DRB398-9 Drawn Copper Cones
See Fig. 11

Round No.	Comp. B (lbs.)	Rotation (rps)	Penetration (inches M.S.)	Max. Spread (in.)	Standard Deviation (inches)
A. T119E11 Penetration Assembly (DRC497 Long Bodies)					
R836	2.88	0	19.75		
R837	2.88	0	21.63		
R838	2.86	0	20.88		
R839	2.88	0	21.94		
R840	2.88	0	20.50		
			Avg. 20.94	2.19	±.88
R841	2.88	15	20.25		
R842	2.88	15	19.06		
R843	2.88	15	20.50		
R844	2.88	15	20.38		
R845	2.88	15	19.00		
			Avg. 19.84	1.50	±.74
B. T119E11 Penetration Assembly (DRC546 Short Bodies)					
R826	2.50	0	18.06		
R827	2.50	0	20.94		
R828	2.50	0	20.56		
R829	2.50	0	20.56		
R830	2.50	0	23.19		
			Avg. 20.66	5.13	±1.82
R831	2.48	15	19.50		
R832	2.50	15	20.56		
R833	2.48	15	20.00		
R834	2.50	15	19.69		
R835	2.50	15	19.19		
			Avg. 19.79	1.37	±.52
C. DRC376 Test Assembly with DRC565 Ogive and DRA699 Cap					
R846	2.58	0	20.44		
R847	2.58	0	20.63		
R848	2.56	0	20.63		
R849	2.56	0	22.81		
R850	2.58	0	20.13		
			Avg. 20.93	2.68	±1.07
R851	2.58	15	20.13		
R852	2.60	15	20.50		
R853	2.60	15	20.63		
R854	2.58	15	20.88		
R855	2.58	15	20.55		
			Avg. 20.53	.75	±.27
D. Controls — DRC376 Test Assemblies (No. 1 Nose Ring)					
R856	2.58	0	21.88		
R857	2.60	0	19.63		
R858	2.58	0	21.13		
R859	2.60	0	18.88		
R860	2.60	0	21.63		
			Avg. 20.63	3.00	±1.31
R861	2.60	15	19.50		
R862	2.62	15	19.50		
R863	2.60	15	17.81		
R864	2.58	15	19.75		
R865	2.60	15	18.25		
			18.96	1.94	±.87

Notes:
1. Cones were drawn copper, DRB398-9, assembled as specified in penetration data headings.
2. Loaded at Ravenna Arsenal, BAT Lot No. 37, with Composition B from Holston Lot No. 4-1197.
3. Tested at Erie Ordnance Depot at the above listed rotations, and at 9.4 inches standoff.
4. Most of the charges left copper slugs in the lower portion of the penetratior cavities.

Aluminum Cones
Effect of Standoff

As a result of a potentially greater damage effectiveness beyond penetrated armor, reported for aluminum cones by NOTS, Inyokern, California, interest in improving the penetration of aluminum cones has increased. At the conventionally employed standoff distances of 2-3 charge diameters 24S-T6 aluminum cones penetrate only 40-45% as far into steel as similarly dimensioned copper cones (Fourth Progress Report). An increase in the wall thickness of the aluminum cone sufficient to give a mass approximately equivalent to a similar copper cone, failed to improve the relative efficiency (Twelfth Progress Report). Realizing that 24S-T6 aluminum alloy has a relatively low ductility, and hoping that the penetration might be improved by annealing, additional aluminum cones were made to copper cone dimensions (3% wall thickness) and a portion were annealed. No improvement in performance resulted from annealing (Twenty-Seventh Progress Report).

The present experiments were undertaken to determine the effect of standoff and cone wall thickness, and to compare the performance of 2S-F and Alloy No. 43 aluminum cones. The cones were made to DRB 398 HW3 specifications and assembled in DRC376 test assemblies with No. 2 Nose Rings (Figs. 35 and 36 of the Thirty-Seventh Progress Report). Aluminum cones were machined from 2S-F bar stock to wall thicknesses of .100 in. (item 1) and .200 in. (item 5). The alloy 43 cones were made to a wall thickness of .150 in. (item 4) and .200 in. (item 5) but were machined from sand castings. Copper cones were used as controls for the study.

The cone inspection data are shown in Tables XVIII to XXII, inclusive, and the penetration data are recorded in Tables XXIII to XXVII and in Figs. 12 and 13. In these figures, data for two sets of copper cones are shown; (1) the standard drawn cones used as controls, and (2) the curve for DRB398HW3 item 1 copper cones machined from copper bar. The latter data were reported in the Thirty-Second Progress Report where it was shown that at standoff distances up to four charge diameters machined and drawn cones had an essentially equivalent performance. The average penetration of the drawn, copper cones used as controls for the aluminum cones, was about two inches greater than was observed in earlier tests with similar cones. This should be kept in mind while comparing the behavior of the aluminum and the machined copper cones. Fig. 14 is a plot of penetration versus wall thickness.

The following observations are pertinent:

(1) Aluminum cones have a much longer optimum standoff than copper cones.
No tests were necessary to make this observation!

(2) At the optimum standoff of approximately 35 to 42 inches (10 to 12 charge diameters) the optimum wall thickness for aluminum cones is near .100 inch, but at short standoff (two charge diameters) the optimum wall thickness is nearer .200 inch.

(3) There is no important difference between the penetration performance of alloy No. 43, 2S-F, or 24S-T6 aluminum cones over the range of standoff studied. At short standoff (two charge diameters) aluminum cones have a penetration efficiency about 40 to 50% that of copper, but at their optimum standoff aluminum cones are from 90 to 100% as effective as copper cones at the same standoff.? ×

This experiment confirms the theory that aluminum cones can give excellent penetration under appropriate standoff conditions, and suggests that aluminum cones might be as effective as copper cones at reasonable standoff if some means can be found of increasing the velocity gradient in the jet.

* do they mean (2 chg diams?) or do they mean at the opt. st. off. for Al? JB

Table XVIII
Inspection Data
DRB398 HW3 Item 1, 2S-F Aluminum Cones

Cone Number	Wall Thickness Inches			Max. Wall Thickness Variation-In		Max. Wall Waviness-In		Concentricity[1,2]		
	Max.	Min.	Avg	Transv	Longitud.	O. D.	I. D.	Base Datum	Apex Datum	Cone Tip In Assembly
Specification DRB 398 HW3 Item 1 Cone	.105	.100		.002	.006	.006	.006	.0030	.0030	.015 (Nominal)
FS1313	.107	.105	.1059	.001	.002	.001	.003	.0010	.0020	.006
FS1314	.107	.105	.1050	.001	.002	<.001	.003	.0040	.0040	.008
FS1315	.108	.105	.1069	.002	.002	.001	.003	.0020	.0030	.003
FS1316	.107	.105	.1056	.001	.002	<.001	.002	.0030	.0030	.003
FS1317	.108	.104	.1056	.001	.004	.001	.004	.0020	.0030	.003
FS1318	.108	.107	.1075	<.001	.001	<.001	.002	.0040	.0030	.006
FS1319	.105	.103	.1040	.001	.002	.001	.002	.0020	.0030	.008
FS1320	.104	.104	.1040	<.001	< .001	.001	.001	.0030	.0040	.004
FS1321	.107	.106	.1065	<.001	.001	<.001	.001	.0010	.0010	.004
FS1322	.108	.104	.1060	.001	.004	.001	.004	.0030	.0030	.002
FS1323	.108	.107	.1074	.001	.001	<.001	.001	.0020	.0040	.005
FS1324	.107	.106	.1065	<.001	.001	.001	.001	.0010	.0020	.003
FS1325	.105	.099	.1020	<.001	.006	.001	.006	.0040	.0050	.007
FS1326	.106	.105	.1059	.001	.001	<.001	.001	.0030	.0020	.002
FS1327	.106	.104	.1050	.001	.002	.001	.002	.0030	.0040	.002
FS1328	.105	.104	.1046	.001	.001	<.001	.001	.0030	.0030	.003
FS1329	.107	.106	.1065	<.001	.001	.001	.002	.0020	.0020	.005
FS1330	.105	.102	.1035	.001	.003	.001	.002	.0040	.0050	<.001
FS1331	.107	.106	.1065	<.001	.001	<.001	.001	.0040	.0050	.006
FS1332	.106	.104	.1053	.001	.002	.001	.002	.0030	.0040	.007
FS1333	.107	.105	.1056	.001	.002	<.00	.002	.0020	.0030	.005
FS1334	.107	.105	.1059	.001	.002	.001	.002	.0020	.0040	.004
FS1335	.105	.103	.1043	.001	.002	<.001	.002	.0040	.0040	.002
FS1336	.107	.105	.1058	.001	.002	<.001	.002	.0030	.0020	.002
FS1337	.106	.103	.1044	.001	.003	.001	.003	.0040	.0050	.005
Avg.	.1065	.1045	.1054	.0010	.0020	.0010	.0022	.0028	.0033	.0042
Std. Dev.	±.0011	±.0017	±.0012	--	±.0012	---	±.0012	±.0010	±.0011	±.0021

Notes:
1. The base datum is .484 inch above base; the apex datum is 3.202 inch above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liner's axis.

Table XIX
Inspection Data
DRB398 HW3 Item 5, 2S-F Aluminum Cones

Cone Number	Wall Thickness (Inches)			Max. Wall Thickness Variation (Inch)		Max Wall Waviness (In.)		Concentricity[1,2]		
	Max	Min.	Avg	Transv	Longitud.	O. D.	I. D.	Base Datum	Apex Datum	Cone Tip In Assembly
Specification DRB398-HW3 Item 5 Cone	.205	.200		.002	.006	.006	.006	.003	.003	.015 (Nominal)
FS1288	.206	.204	.2046	.001	.002	.001	.002	.003	.003	.009
FS1289	.206	.205	.2054	.001	.001	.001	.001	.002	.003	.004
FS1290	.205	.204	.2044	.001	.001	.001	.001	.003	.005	.001
FS1291	.206	.206	.2060	<.001	< .001	.001	< .001	.004	.005	.010
FS1292	.206	.205	.2059	.001	.001	.001	.001	.004	.005	.008
FS1293	.206	.205	.2059	.001	.001	.001	.001	.003	.004	.007
FS1294	.204	.202	.2030	<.001	.002	<.001	.002	.002	.004	.005
FS1295	.206	.205	.2051	.001	.001	.001	.001	.002	.003	.003
FS1296	.207	.205	.2060	.001	.001	.001	.002	.005	.009	.002
FS1297	.205	.205	.2050	<.001	< .001	.001	.001	.004	.003	.007
FS1298	.205	.204	.2049	.001	.001	.001	.001	.004	.004	.003
FS1299	.206	.205	.2051	.001	.001	.001	.001	.004	.004	.008
FS1300	.205	.204	.2048	.001	.001	<.001	.001	.004	.005	.004
FS1301	.206	.203	.2046	.003	.003	.001	.003	.003	.003	.006
FS1302	.206	.205	.2056	.001	.001	.001	.001	.005	.004	.002
FS1303	.206	.205	.2054	.001	.001	.001	.001	.003	.005	< .001
FS1304	.206	.205	.2059	.001	.001	.001	.001	.006	.006	.009
FS1305	.207	.205	.2060	.001	.002	.001	.001	.004	.005	.005
FS1306	.206	.205	.2051	.001	.001	.001	.001	.002	.004	.005
FS1307	.205	.205	.2050	<.001	< .001	.001	.001	.003	.003	.003
FS1308	.206	.204	.2049	.001	.001	.001	.001	.005	.005	.004
FS1309	.205	.204	.2043	.001	< .001	.001	< .001	.003	.002	.001
FS1310	.206	.204	.2050	.001	.001	<.001	.001	.005	.005	.009
FS1311	.206	.205	.2054	.001	.001	.001	.001	.002	.004	.002
FS1312	.206	.205	.2054	.001	.001	<.001	.001	.005	.005	.003
Avg.	.2057	.2046	.2051	.0010	.0010	.0010	.0011	.0036	.0043	.0048
Std. Dev.	±.0006	±.0008	±.0006	---	±.0006	---	±.0006	±.0011	±.0014	±.0028

Notes:
1. Base datum is .484 inch above base; apex datum is 3.202 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liner's axis.

Table XX
Inspection Data
DRB398 HW3 Item 4, Alloy 43, Aluminum Cones

Cone Number	Wall Thickness Inches			Max Wall Thickness Variation-in		Max Wall Waviness-in		Concentricity [1,2]		
	Max.	Min.	Avg.	Transv.	Longitud	O. D	I D.	Base Datum	Apex Datum	Cone Tip in Assembly
Specification DRB 398 HW3 Item 4	.155	.150		.002	.006	.006	.006	.0030	.0030	.0150 (Nominal)
FS1243	.155	.149	.1524	.002	.006	.003	.006	.0030	.0050	.0020
FS1244	.152	.151	.1515	<.001	.001	.002	.001	.0040	.0040	.0020
FS1245	.155	.150	.1529	.002	.002	.002	.002	.0030	.0040	.0040
FS1246	.155	.151	.1535	.004	.003	.003	.003	.0060	.0060	.0050
FS1247	.155	.150	.1524	.001	.005	.003	.005	.0040	.0030	.0040
FS1248	.154	.148	.1518	.004	.004	.002	.004	.0060	.0100	.0020
FS1249	.155	.148	.1524	.006	.004	.003	.004	.0030	.0050	.0060
FS1250	.156	.153	.1550	.002	.003	.003	.003	.0030	.0020	.0110
FS1251	.156	.151	.1534	.001	.004	.003	.004	.0040	.0090	.0070
FS1252	.153	.150	.1514	.003	.001	.003	.002	.0040	.0040	.0050
FS1253	.155	.152	.1540	.003	.002	.003	.002	.0050	.0040	.0060
FS1254	.156	.151	.1540	.002	.004	.003	.004	.0050	.0070	.0050
FS1255	.154	.151	.1525	.001	.002	.003	.003	.0060	.0080	.0090
FS1256	.155	.147	.1514	.007	.004	.003	.004	.0040	.0050	.0020
FS1257	.156	.154	.1549	.002	.001	.003	.004	.0060	.0040	.0050
Avg.	.1548	.1504	.1529	.0027	.0031	.0028	.0034	.0044	.0053	.0050
Std. Dev.	±.0012	±.0019	±.0012	±.0019	±.0015	±.0005	±.0013	±.0012	±.0023	±.0026

Notes:

1. Base datum is 0.484 inch above base; apex datum is 3.202 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liner axis.

Table XXI
Inspection Data
DRB398 HW3 Item 5, Alloy 43, Aluminum Cones

Cone Number	Wall Thickness inches			Max. Wall Thickness Variation-in.		Max Wall Waviness-in.		Concentricity [1,2]		
	Max.	Min.	Avg	Transv	Longitud	O. D.	I. D.	Base Datum	Apex Datum	Cone Tip in Assembly
Specification DRB 398 HW3 Item 5	.205	.200		.002	.006	.006	.006	.0030	.0030	.015 (Nominal)
FS1258	.204	.200	.2024	.003	.002	.003	.002	.0050	.0040	.0050
FS1259	.204	.198	.2019	.005	.005	.002	.005	.0050	.0050	.0050
FS1260	.196	.181	.1896	.008	.015	.003	.015	.0050	.0050	.0040
FS1261	.207	.202	.2048	.003	.004	.003	.004	.0060	.0050	.0030
FS1262	.202	.198	.2005	.003	.004	.003	.004	.0050	.0040	.0060
FS1263	.202	.196	.1998	.004	.004	.003	.004	.0060	.0060	.0070
FS1264	.204	.200	.2018	.002	.004	.002	.004	.0040	.0030	.0030
FS1265	.206	.202	.2038	.002	.002	.003	.002	.0050	.0040	.0080
FS1266	.204	.201	.2021	.003	.002	.003	.003	.0050	.0060	.0050
FS1267	.209	.203	.2051	.005	.004	.003	.004	.0050	.0060	.0090
FS1268	.205	.202	.2036	.003	.002	.003	.002	.0050	.0030	.0060
FS1269	.206	.203	.2045	.001	.002	.003	.002	.0040	.0030	.0050
FS1270	.203	.199	.2015	.004	.003	.003	.003	.0030	.0030	.0090
FS1271	.205	.203	.2044	.002	.002	.002	.002	.0040	.0030	.0030
FS1272	.206	.203	.2050	.002	.002	.003	.002	.0020	.0020	.0030
Avg.	.2042	.1994	.2021	.0033	.0038	.0028	.0039	.0046	.0041	.0054
Std. Dev.	±.0029	±.0055	±.0038	±.0017	±.0033	±.0005	±.0033	±.0011	±.0013	±.0021

Notes:

1. Base datum is 0.484 inch above base; apex datum is 3.202 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liner axis.

Table XXII
Inspection Data
DRB398 HW3 Item 1, Drawn Copper Cones

Cone Number	Wall Thickness (inches)			Max Wall Thickness Variation (in.)		Max Wall Waviness (inch)		Concentricity[1,2]		
	Max.	Min.	Avg.	Transv.	Longitud.	O. D.	I. D.	Base Datum	Apex Datum	Cone Tip In Assembly
Specification DRB 398-HW3 Item 1 Cones	.105	.100		.002	.006	.006	.006	.0030	.0030	.015 (Nominal)
R86	.101	.100	.1003	.001	.001	.002	.002	.0020	.0020	.008
R87	.101	.099	.0996	.002	.001	.002	.002	.0020	.0020	.004
R88	.102	.100	.1008	.002	.002	.002	.002	.0030	.0030	.003
R89	.103	.102	.1025	.001	.001	.003	.003	.0020	.0020	.003
R90	.100	.099	.0998	.001	.001	.003	.002	.0020	.0030	.001
R91	.101	.100	.1001	.001	.001	.003	.002	.0020	.0020	.001
R92	.106	.103	.1050	.003	.002	.002	.002	.0020	.0030	.004
R93	.104	.102	.1028	.002	.001	.003	.002	.0020	.0030	.002
R94	.101	.100	.1001	.001	.001	.002	.002	.0050	.0050	.004
R95	.103	.101	.1020	.002	.001	.002	.002	.0010	.0010	.002
Avg.	.1022	.1006	.1013	.0016	.0012	.0024	.0021	.0023	.0026	.0032
Std. Dev.	±.0018	±.0014	±.0017	±.0007	±.0005	±.0006	±.0003	±.0011	±.0011	±.0021

Notes:
1. Base datum is .484 inch above base; apex datum is 3.202 inches above base.
2. The indicated measurement at each datum is the total indicator runout of the liner's outside surface relative to the register diameter. The difference between the runout at the two datum planes is an indication of the lack of perpendicularity of the register plane and the liner's axis.

Table XXIII
Penetration Data
DRB398 HW3 Item 1, 2S-F Aluminum Cones
Effect of Standoff

Round No	Comp B (lbs)	Standoff (in)	Penetration (inches M S)	Max Spread (in)	Std Deviation (in)
FS1313	2.48	7.5	8.62		
FS1314	2.46	7.5	9.12		
FS1315	2.46	7.5	9.06		
			Avg. 8.93	.50	±.27
FS1316	2.46	15.0	11.38		
FS1317	2.46	15.0	11.69		
FS1318	2.46	15.0	10.88		
			Avg. 11.32	.81	±.41
FS1319	2.46	22.5	13.44		
FS1320	2.48	22.5	15.31		
FS1321	2.48	22.5	14.56		
			Avg. 14.44	1.87	±.94
FS1322	2.46	30.0	17.62		
FS1323	2.48	30.0	17.18		
FS1324	2.48	30.0	17.00		
			Avg. 17.27	.62	±.32
FS1325	2.46	42.0	21.06		
FS1326	2.48	42.0	20.31		
FS1327	2.50	42.0	20.94		
			Avg. 20.77	.75	±.40
FS1334	2.46	45.0	14.56		
FS1335	2.46	45.0	14.38		
			Avg. 14.47	.18	---
FS1331	2.46	48.0	16.94		
FS1332	2.46	48.0	16.94		
FS1333	2.48	48.0	18.88		
			Avg. 17.59	1.94	±1.12
FS1336	2.46	51.0	13.18		
FS1337	2.46	51.0	12.56		
			Avg. 12.87	.62	--
FS1328	2.46	54.0	8.12		
FS1329	2.46	54.0	8.38		
FS1330	2.46	54.0	8.75		
			Avg. 8.42	.63	±.32

Notes:
1. Cones were machined from aluminum bar (2SF), assembled in DRC376 test bodies, base plugs and No. 2 nose rings.
2. Loaded at Ravenna Arsenal, BAT Lot No. 31, with Composition B from Holston Lot No. 4-1197.
3. Tested at Erie Ordnance Depot at 0 rps.
4. One characteristic of these charges is that very few slugs are recovered.

.100 wall thickness

Table XXIV
Penetration Data
DRB398 HW3 Item 5, 2S-F Aluminum Cones
Effect of Standoff

Round No.	Comp. B (lbs.)	Standoff (in.)	Penetration (inches M.S.)	Max. Spread (in.)	Std. Deviation (in.)
FS1288	2.48	7.5	9.38		
FS1289	2.48	7.5	9.94		
FS1290	2.48	7.5	10.00		
			Avg. 9.77	.62	±.34
FS1291	2.46	15.0	13.31		
FS1292	2.46	15.0	13.25		
FS1293	2.46	15.0	13.38		
			Avg. 13.31	.13	±.07
FS1294	2.46	22.5	15.81		
FS1295	2.46	22.5	15.94		
FS1296	2.48	22.5	14.18		
			Avg. 15.31	1.76	±.98
FS1297	2.48	30.0	15.44		
FS1298	2.48	30.0	16.18		
FS1299	2.48	30.0	15.44		
			Avg. 15.69	.74	±.43
FS1300	2.48	42	16.81		
FS1301	2.48	42	16.69		
FS1302	2.48	42	15.88		
			Avg. 16.45	.93	±.51
FS1309	2.48	45	16.69		
FS1310	2.46	45	16.38		
			Avg. 16.54	.31	
FS1306	2.46	48	17.38		
FS1307	2.48	48	17.06		
FS1308	2.48	48	15.81		
			Avg. 16.75	1.57	±.83
FS1311	2.46	51	15.81		
FS1312	2.46	51	17.31		
			Avg. 16.56	1.50	
FS1303	2.48	54	16.18		
FS1304	2.50	54	16.44		
FS1305	2.48	54	15.56		
			Avg. 16.06	.88	±.45

.200" wall thickness

Notes:
1. Cones were machined from aluminum bar (2 S-F) assembled in DRC376 test bodies, plugs and No. 2 nose rings.
2. Loaded at Ravenna Arsenal, BAT Lot No. 31, with Composition B from Holston Lot No. 4-1197.
3. Tested at Erie Ordnance Depot at 0 rps.
4. All charges left aluminum slugs in the target which were extruded down into the bottom of the cavity.

Table XXV
Penetration Data
DRB398 HW3 Item 4, Alloy 43, Aluminum Cones
Effect of Standoff

Round No	Comp. B (lbs.)	Standoff (in)	Penetration (inches M.S)	Max Spread (in)	Standard Deviation (in.)
FS1243	2.46	7.5	10.13		
FS1244	2.48	7.5	9.69		
FS1245	2.48	7.5	9.94		
			Avg. 9.92	.44	±.22
FS1246	2.48	15.0	11.81		
FS1247	2.48	15.0	13.87		
FS1248	2.48	15.0	13.69		
			Avg. 13.12	2.06	±1.14
FS1249	2.46	30.0	16.31		
FS1250	2.46	30.0	18.63		
FS1251	2.48	30.0	19.31		
			Avg. 18.08	3.00	±1.57
FS1252	2.50	42.0	17.50		
FS1253	2.48	42.0	16.63		
FS1254	2.46	42.0	18.69		
			Avg. 17.61	2.06	±1.03
FS1255	2.48	54.0	18.44		
FS1256	2.48	54.0	17.25		
FS1257	2.50	54.0	14.75		
			Avg. 16.81	3.69	±1.88

Notes:

1. Cones were machined from aluminum alloy No. 43 sand castings, assembled in DRC 376 test bodies, plugs and No. 2 nose rings.
2. Loaded at Ravenna Arsenal, BAT Lot No. 36, with Composition B from Holston Lot No. 4-1197.
3. Tested at Erie Ordnance Depot at 0 rps.
4. One characteristic of these charges was that only a few slugs were recovered.

Table XXVI
Penetration Data
DRB398 HW3 Item 5, Alloy 43, Aluminum Cones
Effect of Standoff

Round No	Comp. B (lbs.)	Standoff (in.)	Penetration (inches M.S)	Max Spread (in.)	Standard Deviation (in)
FS1258	2.48	7.5	11.44		
FS1259	2.50	7.5	9.69		
FS1260	2.50	7.5	11.25		
			Avg. 10.79	1.75	±.96
FS1261	2.48	15.0	11.69		
FS1262	2.48	15.0	12.31		
FS1263	2.48	15.0	13.37		
			Avg. 12.46	1.68	±.85
FS1264	2.50	30.0	17.06		
FS1265	2.48	30.0	17.13		
FS1266	2.48	30.0	16.31		
			Avg. 16.83	.82	±.45
FS1267	2.48	42.0	17.13		
FS1268	2.52	42.0	15.63		
FS1269	2.50	42.0	15.75		
			Avg. 16.17	1.50	±.83
FS1270	2.48	54.0	13.75		
FS1271	2.48	54.0	11.81		
FS1272	2.50	54.0	18.50		
			Avg. 14.69	6.69	±3.44

Notes:

1. Cones were machined from sand castings (Alloy #43), assembled in DRC 376 test bodies, plugs and No. 2 nose rings.
2. Loaded at Ravenna Arsenal, BAT Lot No. 36, with Composition B from Holston Lot No. 4-1197.
3. Tested at Erie Ordnance Depot at 0 rps.
4. At the 7.5 inch standoff the charges left a small slug in the cavity throat. At the 15.0 inch standoff the charges left aluminum slugs in the target. The slugs were extruded down into the bottom of the cavity. In the higher standoff positions no slugs were recovered.

Table XXVII
Penetration Data
DRB398 HW3 Item 1, Copper Cone Controls
Effect of Standoff

Round No.	Comp. B (lbs.)	Standoff (in.)	Penetration (inches M.S.)	Max. Spread (in.)	Standard Deviation (in.)
R86	2.44	7.5	21.50		
R87	2.46	7.5	22.94		
R88	2.46	7.5	22.25		
R89	2.48	7.5	22.56		
R90	2.48	7.5	21.38		
			Avg. 22.13	1.56	±.67
R91	2.46	15.0	24.31		
R92	2.48	15.0	20.38		
R93	2.48	15.0	24.31		
R94	2.48	15.0	22.56		
R95	2.48	15.0	24.56		
			Avg. 23.22	4.18	±1.78

Notes:
1. Cones were drawn copper, DRB 398 HW3 item 1, assembled in DRC 376 test bodies, plugs and No. 2 nose rings.
2. Loaded at Ravenna Arsenal, BAT Lot No. 36, with Composition B from Holston Lot No. 4-1197
3. Tested at Erie Ordnance Depot at 0 rps.
4. All the charges except one left copper slugs in the lower portion of the cavities.

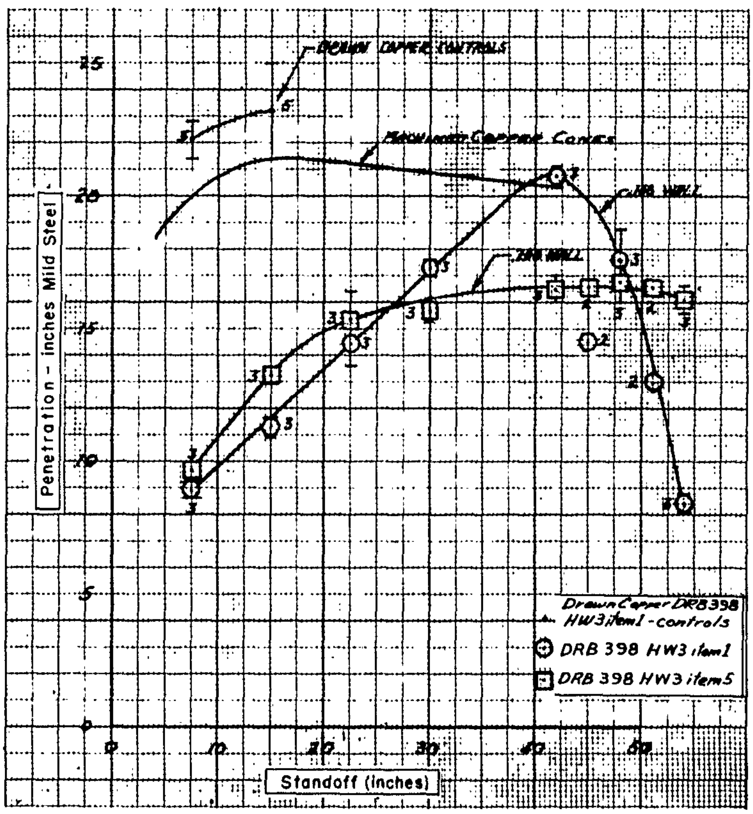

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Fig. 12. Penetration Versus Standoff.
2S-F Aluminum Cones.

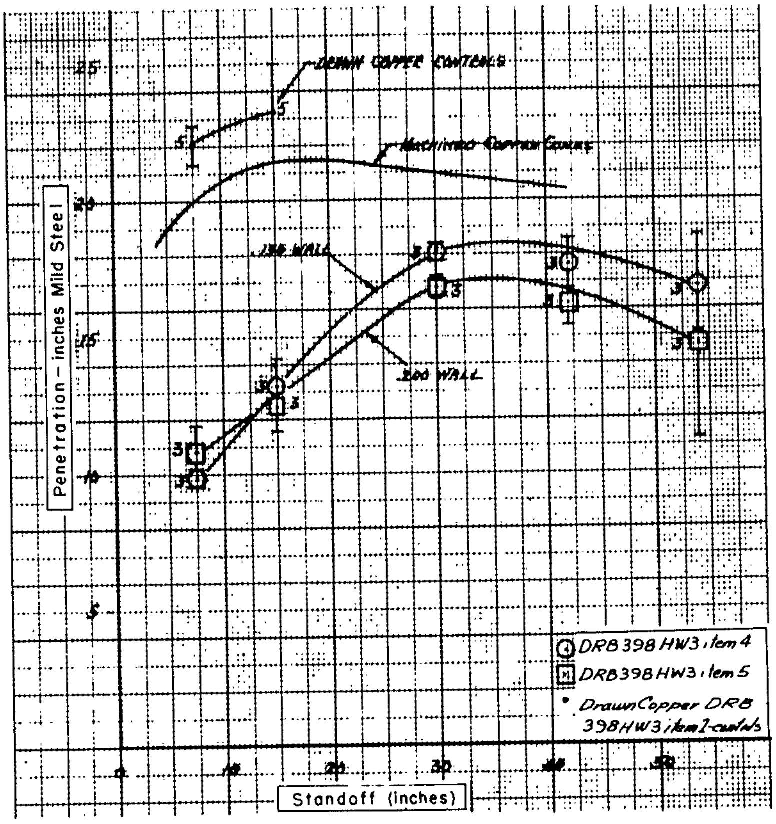

Fig. 13. Penetration Versus Standoff.
Alloy No. 43 Aluminum Cones.

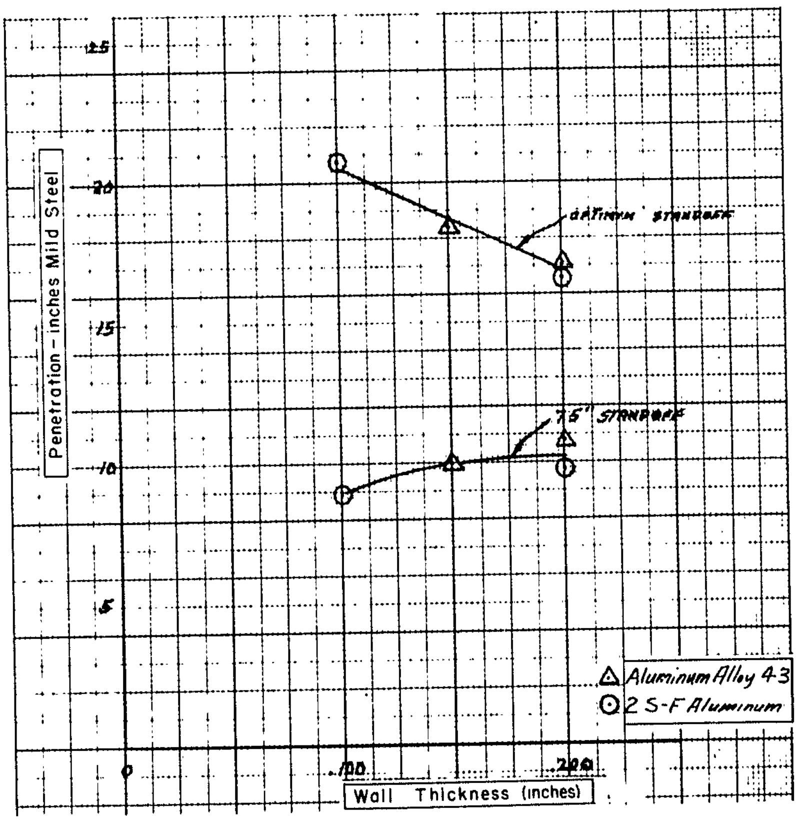

Fig. 14. Penetration Versus Wall Thickness.
Aluminum Alloy Cones.

Future Program

1. Cones made of Zamak 5 are to be tested for penetration behavior. Penetrations approaching those of copper cones have been obtained for certain zinc alloys.

2. Composite Cone Study

A series of tests of bimetal cones with aluminum liners and copper shells are being manufactured for testing:

a. .080-inch thick copper shell and .020 and .040-inch aluminum insert (24S-T4).

b. .100-inch thick copper shell and .020 and .040-inch aluminum insert (24S-T4).

c. Same as (a) and (b) but using 2S-F aluminum instead of 24S-T4.

d. Same as (b) but using two stamped 2S inserts in each cone.

e. Same as (b) except aluminum is sprayed (metalized) into inside of cone and then machined fo final dimensions.

3. Comparison of Cones made by "Spinning" and by "Drawing".

Forty-two copper cones manufactured by a spinning process will be tested for penetration behavior and compared with cones made by other methods. These cones are P83580A1 cones designed for use in the 90mm T108 E40 projectile.

4. Evaluation of Cones made by Electroforming.

A series of DRB681 copper cones made by an electroforming method are being manufactured for comparison with machined cones.

5. The Effect of Rotation on Aluminum Cone Performance.

A series of DRB398 HW3 item 1 and item 4 cones, machined from 2SF aluminum bar stock, will be tested for penetration behavior at various spin rates.

6. Penetration into Mild Steel versus Homogeneous Armor.

A series of penetration rounds will be fired at various standoffs and rotations to determine the effect of the mild steel and homogeneous armor plate on penetration.

T267E14 Base Element

In a test reported in the Thirty-Seventh Progress Report, eight of ten T267E14 base elements, set for delay, functioned when fired against a 4-inch wooden screen. An additional ten of these base elements, also set for delay, have been fired against a 1-inch wooden screen at a range of approximately 200 yards. All ten functioned satisfactorily. Table XXVIII is a copy of the firing record.

Because the performance of the T267 E14 base elements is satisfactory, one hundred are being manufactured for Engineering Tests. Delivery is scheduled for December, 1953.

Fuze Nose Elements

Until such time as a fuze base element with graze sensitivity is approved for the T119E11 projectile it will be necessary to obtain graze sensitivity by reducing the force required to deform the nose cap. The design of the nose cap has been examined and the following design changes are being considered:

1. Reduce the wall section of the nose cap to allow for easier deformation.

2. Adapt a Sprague potted "lucky" element for use in the T119E11 projectile. ? this was tried in the T205 and was not found satisfactory.

3. Use a stab type nose detonator to exert a force on the present "lucky" element when the detonator is activated by impact.

Tests to investigate the effects of these changes on graze functioning are being planned.

Effectiveness of Resistance Washers in Preventing Prematures

A resistance washer, having a resistance of 90,000 to 200,000 ohms, has been used as a standard component of the fuze system incorporated in T119 and T138 rounds. This washer is connected across the detonator and is intended to bleed off any electrical charge developed by the "lucky" element as a result of setback before the fuze is armed. This washer provides an additional safety against prematures.

At the request of Office, Chief of Ordnance, this program was initiated to demonstrate the effectiveness of the washer in the prevention of prematures.

To test the effectiveness of the washer it was necessary to find means for producing a high frequency of prematures in rounds not equipped with resistance washers, and to compare the results with similar rounds equipped with resistance washers.

After several experiments in which various nose caps were tested in an effort to produce prematures at will, a special nose cap, shown in Fig. 15, was devised. Under setback stresses the pin, A, shears and allows the heavy slug to impact against the crystal. Fifty rounds were fired using

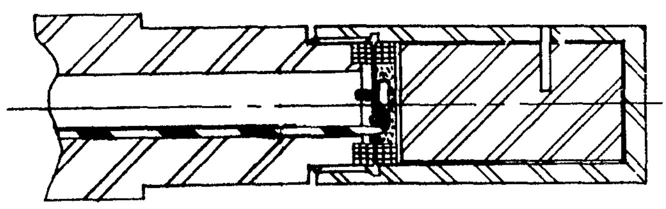

Fig. 15. Special Tee Cap.
Study of Prematures.

the special cap; 31 prematured at an average distance of 13 ft. from the muzzle of the gun and the remaining rounds functioned on impact at the target plate.

Having established that this method produces a high percentage of prematures, twenty rounds were equipped with resistance washers and fired under the same conditions as the previous test rounds. The washer used in the first round had a resistance range of 500,000 to 1,000,000 ohms. This round prematured and the washer was replaced by one having a resistance range of 300,000 to 400,000 ohms. Using this resistance washer, twenty additional rounds were fired without any prematures.

These data indicate that the resistance of the first washer (500,000 to 1,000,000 ohms) was too high to allow the charge generated by setback to discharge before the base element armed. Further tests are planned to determine just how small a resistance may be used without jeopardizing the proper functioning of the round upon impact with the target.

At the request of OCO, tests are being extended to include nose element designs of the type used in T184 rounds. When a satisfactory method for producing prematures with this nose element is found, tests to determine the proper range of resistance values for this projectile will be initiated.

Future Program

(1) Establish a means for producing prematures in T184 type rounds.

(2) Establish a range of resistance values for the washers which will prevent prematures but which will not prevent proper functioning of the round upon striking the target.

(3) Manufacture 100 T267E14 base elements for Engineering Tests.

(4) Evaluate "graze sensitive" systems for the T119E11 projectiles.

(a) T267E14 base elements.
(b) Stab type nose detonator elements.
(c) Potted "lucky" elements.
(d) Reduced wall nose caps.

Table XXVIII
Range Data
Testing T267E14 Base Elements

Date of Test Sept. 9, 1953

Purpose of Test T267 Fuze

Gun — 66'2" — 1 — 94'1" — 2

Screen Distances

PROJECTILE

Model T138

Type E57A

Weight 17.2 lb. (nom)

C.G. Location —

Bourrelet Dia 4.132 in. −.002

Special Features T267 fuze, 360·3 band

Retard. Factor 0.245 ft/sec/ft

TEST GUN

Model T137E3

Type 105mm recoilless

Serial No 4

Chamber B-4443-11-B

Bushing (Vent) 22-B-374-4

Tube 105 in, 1/20 cal twist

Sighting Equipment M17 Elbow Telescope

Mount

Type Pendulum

Constant 2.48 lb-sec/in

Lanyard Fired Manually

MISCELLANEOUS DATA

Range 200 yd. 1 in. bursting screen

Propellant

Type M10MP Web .033 in. Weight 7 lb. 13 oz.

Lot No PA 30252

Primer M57

Shell Case T51E1, T52E1

Liner T6

Temperatures

Magazine

Max — Min — Present —

Loading Room — Ambient —

Round No	Shell Case No.	Proj No.	Piezo Gage No.	Fuze Function	Chamber Pressure (lb/sq in)	Muzzle Velocity ft/sec Instr	Muzzle Velocity ft/sec Actual	Elev (mils)	Azimuth (mils)	Position of Hit Vert	Position of Hit Horiz	Corrected Position of Hit — mils Vert	Corrected Position of Hit — mils Horiz	Recoil (in)	Observations
5763	H-6	X1144	16	Yes	12800 13100	1814	1842							3R	Case O.K
5764	H-4	X1140	16	"	12400 12800	1826	1854							1/2 R	" "
5765	PT-13	X1145	16	"	—	1816	1844							2F	" "
5766	H-10	X1143	216	"	—	1803	1831							4F	" "
5767	H-11	X1142	216	"	—	1802	1830							4F	" "
5768	H-2	X1141	216	"	—	1816	1844							4F	" "
5769	H-3	X1139	X192	"	—	1795	1823							4F	" "
5770	H-9	X1138	X192	"	—	1803	1831							3F	" "
5771	H-7	X1146	X192	"	—	1810	1838							4F	" "
5772	PT-14	X1147	X192	"	—	1803	1831							6F	" "

Signed M. Manofsky

MANUFACTURING SUMMARY

In addition to the experimental material prepared for the research and development work under contracts DA-33-019-ORD-33 and DA-33-019-ORD-1202, described in preceding progress reports and in the preceding pages of this report, the following have been manufactured and shipped to the installations indicated.

Firestone's Defense Research Division, in shipping these items, transfers custody and control of the items to the receiving agencies. However, personnel of Defense Research Division will continue to collaborate with personnel of the other installations.

I. Cartridges, T119E11, Metal Parts Assembly, w/o Fuze T208E7

Prior to September 1, 1953	7980	All Shipments
September 5, 1953	300 (Live)	Picatinny Arsenal
September 10, 1953 (First group shipped with 106 mm marking)	100 (Inert)	Aberdeen Proving Ground
September 14, 1953 (Above group were marked 105 mm)	200 (Live)	Picatinny Arsenal
September 14, 1953 (Above group were marked 106 mm M344)	100 (Inert)	Picatinny Arsenal
September 15, 1953 (Above were M344)	100 (Inert)	Picatinny Arsenal
September 18, 1953 (Above were M344)	400 (Inert)	Picatinny Arsenal
September 25, 1953 (Above were M344)	500 (Inert)	Picatinny Arsenal
Total	9680	

II. Rifles, T170E1 for ONTOS

Prior to July 1, 1953	30	Aberdeen Proving Ground
July 24, 1953	6	" " "
Aug. 10, 1953	6	" " "

III. Mounts, T173 and T26 Tripod for ONTOS

Prior to Aug. 1, 1953	1	Allis Chalmers
Aug. 4, 1953	3	" "
Sept. 4, 1953	2	
Sept. 10, 1953	4	

IV. BAT Systems less Jeep, T170E1 (M40) Rifle, T149E3 (M79) Mounts

Prior to Sept. 1, 1953	11	All Shipments
Sept. 5, 1953	1	Aberdeen Proving Ground

DISTRIBUTION

Number of Copies	NUMBERS	INSTALLATION
		Office, Chief of Ordnance
1	1	ORDTS
2	2-3	ORDTA
1	4	ORDTQ
1	5	ORDTB
1	6	ORDGU-SE
1	7	ORDTU
1	8	ORDIM
1	9	Electric Mechanical Ordnance Division
		Arsenals
10	10-19 incl.	Frankford
2	20-21	Picatinny
1	22	Springfield Armory
2	23-24	Redstone
		Ordnance Districts
1	25	Cleveland
		Aberdeen Proving Ground
2	26-27	Ballistics Research Laboratory
1	28	Development and Proof Services
		Contractors
2	29-30	Frigidaire Div. Gen. Motors Corp.
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2	44-45	Naval Ordnance Laboratory, White Oak
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1	48	Naval Proving Ground, Dahlgren